Science

The American Midland Naturalist

Founded by J. A. Nieuwland, C.S.C.

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CONTENTS

No. 1, July, 1950

The Species of Peltigera of North America North of Mexico.....John W. Thomson, Jr. 1

The Vegetation of Stock Pond Dams in Central Oklahoma.....Ralph W. Kelting and William T. Penfound 69

The Fishes of the Illinois River in Oklahoma and Arkansas.....George A. Moore and John M. Paden 76

Biological and Economic Notes on the Sharks of the Gulf of Mexico, With Especial Reference to Those of Texas, and With a Key for their Identification.....J. L. Baughman and Stewart Springer 96

Studies on North American Chiggers. No. 3. The Subgenus Neotrombicula.....James M. Brennan and G. W. Wharton 153

Variations in the Gonopods of a Xystodesmid Diplopod.....Nell Bevel Causey 198

Measurements in the Worker Caste of Two Species of Eciton (Neivamyrmex Borgmeier) (Hymenoptera: Formicidae....D. S. Gillespie and A. C. Cole 203

Additions to the Description of Plumatella repens furcifer Jullien.....W. S. Newcomer 205

The Vertebrate Fauna and Geologic Age of Trinity River Terraces in Henderson County, Texas.....J. Willis Stovall and William N. McAnulty 211

Notes and Discussion
Isoetes melanopoda Still Grows in Illinois.....Julian Neill 251

Book Reviews 252

No. 2, September, 1950

Mites of the Family Tetranychidae.....E. A. McGregor 257

The Genus Cambarellus in Louisiana (Decapoda, Astacidae).....George Henry Penn 421

The Oviposition of Dermestes ater Degeer, With Notes on Bionomics Under Laboratory Conditions.....Louis M. Roth and Edwin R. Willis 427

The Mussels of the Mississippi River.....Henry and Annette van der Schalie 448

Parasites of Muskrats in Maine.....Marvin C. Meyer and James R. Reilly 467

High Temperatures and the Seasonal Distribution of Precipitation and Some Ecological Consequences or Correlations.....Stephen S. Visher 478

The Centennial of Charles Wright's Trip Through Trans-Pecos Texas.....L. C. Hinckley 488

Poisoning Certain Undesirable Southern Hardwoods for Forest and Range Improvement.....Robert S. Campbell and Fred A. Peevy 495

Phyllotaxy.....Albert Chandler 506

Book Reviews 509

No. 3, November, 1950

A Contribution to Our Knowledge of the Wild and Cultivated Flora of Chiapas—I. Districts Soconusco and Mariscal.....Eizi Matuda 513

Notes on the Illinois Flora ..... Robert A. Evers 617
Studies in Florida Botany 8. The Genus Habenaria in Florida.... Alex D. Hawkes 622
Notes on Wisconsin Parasitic Fungi. XIV ..... H. C. Greene 630
Utilization of Crawfishes by Cold-Blooded Vertebrates in the Eastern United States ..... George Henry Penn 643
A Survey of the Insects of White Sands National Monument, Tularosa Basin, New Mexico ..... Clyde P. Stroud 659
A Revised Nomenclature for the Chaetotaxy of the Mosquito Larva (Diptera: Culicidae) ..... John N. Belkin 678
The North American Species of Bembecinus (Hymenoptera, Sphecidae, Stizini) ..... Karl V. Krombein and Abraham Willink 699
A Boy Attacked by a Shark, July 25, 1936 in Buzzard's Bay, Massachusetts With Notes on Attacks by Another Shark along the New Jersey Coast in 1916 ..... E. W. Gudger 714
Notes on the Behavior of Horned Toads ..... Lorus J. and Margery J. Milne 720
Growth and Feather Development of Towhee Nestlings ..... Roger W. Barbour 742
The Striped Dolphin, Lagenorhynchus obliquidens Gill 1865, on the Coast of North America ..... Victor B. Scheffer 750

Notes and Discussion

Notes on the Distribution of the Frogs and Toads of Kentucky ..... Roger W. Barbour 759
A New Distribution Record for Beckmannia eruceaformia (L.) ..... P. E. Hebert, C.S.C. 760
Note on the Distribution of the "Plume Poppy" ..... A. L. Delisle 760
Book Reviews 761

Dates of Publication
Volume 44, 1950

July ..... July 17
September ..... September 25
November ..... February 12, 1951

617
622
630
643
659
678
699
714
720
742
750
759
760
760
761

Science Library

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Notes and Discussion

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Book Reviews 252

Vol. 44 July, 1950 No. 1

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The Species of Peltigera of North America North of Mexico*

John W. Thomson, Jr.

Department of Botany, University of Wisconsin, Madison

INTRODUCTION

In this paper I have attempted to treat in monographic form those species of the lichen genus *Peltigera* which occur in North America north of Mexico. The study is based upon the collections in the major herbaria of the United States. Access to as many authentic and type specimens as was possible during the circumstances was sought. The conditions imposed by the second World War naturally cut off access to the European herbaria and made their impress upon the course of the work. Fortunately the collections at the Farlow Herbarium and Yale University contained many specimens determined by V. Gyelnik so that the numerous names proposed by this recent worker could be evaluated in the light of American material. As is only natural, there are disagreements over species limitations and I have followed a concept of broader limits than those expressed by this monographer in the numerous papers which he has published in preparation of a monograph of the *Peltigeras* of the world. Sufficient criticism of his too finely drawn distinctions has already been voiced in many papers of other lichenologists; my own disposition of many of his proposed names may be traced in the synonymy.

Although Zahlbruckner has proposed conservation of the name *Peltigera*, citing the name as being proposed by Persoon in 1794, and antedated by *Byrsalis* of Necker in 1790, this is not necessary as the name was actually proposed by Willdenow in 1787 in *Florae Berolinensis Prodromus*. This contained the generally accepted type species *P. canina* (L.) Willd. The early authors included species now placed in *Solorina*, *Nephroma*, and even *Sticta* in their concept of *Peltigera*. Rabenhorst in 1845 emended the genus to include its present restricted sense.

There have been proposals that the genus be divided into two, *Peltidea* and *Peltigera*, the divisions being based upon the presence of Chlorophyceae or Myxophyceae as algal constituents of the thallus. Aside from this one difference (and it is an inconstant one, the cephalodia of those whose algae are Chlorophyceae contain Nostoc) the great uniformity of structure through the various species of this highly organized lichen makes it difficult to agree with those who would make the division.

* This work was supported in part by a grant from the Special Research Fund of the University of Wisconsin.

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For the generous loan of material from their respective herbaria I am greatly indebted to Drs. C. W. Dodge, Francis Drouet, A. W. Evans, A. W. Herre, Grace E. Howard, Joyce Hedrick Jones, W. R. Maxon, F. W. Pennell, C. O. Rosendahl, Fred J. Seaver, John A. Stevenson, and John N. Wolfe. To the late Dr. David Linder I am especially indebted for his hospitality and help in making so completely available the facilities and collections of the Farlow Herbarium. The assistance and suggestions of Dr. N. C. Fassett of the University of Wisconsin are gratefully acknowledged. Nor should the hospitality of Dr. E. M. Gilbert of the University of Wisconsin, in making available his summer home during field studies, and the help of my wife, Olive S. Thomson, go unacknowledged. To them I am also grateful.

The abbreviations used for the Exsiccatae examined are as listed in Bernt Lynge's Index and Supplement with the following additions.

Macoun—Macoun Canadian Lichens
Suza—Lichenes Bohemoslovakiae
Thoms—Lichenes Wisconsinenses Exsiccati

The abbreviations used to indicate the various herbaria in which the specimens cited are located are as follows:

C—Chicago Museum of Natural History
D—Private herbarium of C. W. Dodge
DA—U. S. Department of Agriculture, Beltsville, Maryland
F—Farlow Herbarium, Harvard University
H—Private herbarium of A. W. Herre, recently purchased by Chicago Museum of Natural History
Mich—University of Michigan, Ann Arbor, Michigan
Minn—University of Minnesota, Minneapolis, Minnesota
Mo—Missouri Botanical Garden, St. Louis, Missouri
NY—New York Botanical Garden
O—Ohio State University, Columbus, Ohio
P—Philadelphia Academy of Science
T—Private herbarium of the author
US—U. S. National Herbarium, Smithsonian Institution, Washington, D. C.
Wel—Wellesley College
Wis—University of Wisconsin
Wolfe—Private herbarium of John N. Wolfe, Ohio State University
Y—Yale University

All measurements, including spore sizes, were made from freehand sections in water mounts.

The usual abbreviations for the chemical tests have been used in this paper, i. e., K is potassium hydroxide, C is calcium hypochlorite, KC is a mixture of the two, P is for paraphenylenediamine, and I a solution of iodine in potassium iodide.

The base map for the maps of distribution is Halls outline map 205 C, used by permission of the publishers, John Wiley and Sons.

PELTIGERA Willd. emend L. Rabenh.

Deutsch. Crypt. Flor. II. 1845.—*Peltigera* Willd. Flor. Berolinens. Prod. 347. 1787. —*Byrsalis* Neck. Elem. Bot. III: 349. 1790.—*Peltidea* Ach. Nov. Act. Reg. Acad. Sc. Suec. Holmiae 15: 244. 1794.—*Peltigera* D. *Antilyssa* Wallr. Flor. Crypt. Germ. III: 557. 1831.

Thallus foliose, more or less lobed, loosely attached to the substrate by rhizinae; differentiated into a plectenchymatous upper cortex, a continuous algal layer, and a loosely interwoven layer of medullary hyphae to which the rhizinae are attached, lower cortex lacking, the lower surface usually more or less veined; upper surface smooth, scabrid or with superficial hyphae, especially at the margins. Apothecia round, marginal or on marginal lobules, horizontal

or vertical, often with the sides reflexed; exciple lacking, a cortical rim around the apothecium which is sunken in the thallus, the margins usually becoming crenate, hypothecium hyaline to brown, hymenium hyaline to brownish, upper part of the paraphyses red-brown, paraphyses simple, asci cylindrico-clavate, the upper part considerably gelatinized; spores 8, fusiform or acicular, sometimes slightly curved, 3-9 septate. Algae *Nostoc* or *Dactylococcus*.

KEY TO THE NORTH AMERICAN SPECIES OF PELTIGERA

1. Algae of the thallus Chlorophyceae; warty cephalodia containing Nostoc on the upper or lower surface of the thallus ..... Sect. Phlebia Wallr.
   2. Upper side of the thallus with warty cephalodia and often marginally erect tomentose; under surface with scattered fasciculate rhizinae; thallus and lobes large, up to 6 cm. across; apothecia vertical ..... 1. *P. aphthosa*.
   2. Upper side of the thallus lacking cephalodia and etomentose; under side with small black cephalodia on the veins; attached centrally or at one side by a group of rhizinae; thallus small, up to 2 cm. across; apothecia horizontal ..... 2. *P. venosa*.
1. Algae of thallus Myxophyceae; thallus lacking cephalodia ..... Sect. Emprostea (Ach.) Wainio.
   3. Thallus upper side smooth or verruculose-scabrid, lacking tomentum.
      4. Thallus margin sorediate ..... 3. *P. scutata*.
      4. Thallus margin esorediate.
         5. Upper side verruculose-scabrid.
            6. Upper side with scattered to clustered cylindrical isidia, under side with veins narrow and strongly raised (caninaeforme) ..... 4. *P. evansiana*.
            6. Upper side without scattered cylindrical isidia, under side with broader, less raised veins (polydactylaeforme) ..... 5. *P. scabrosa*.
         5. Upper side smooth, lacking tomentum.
            7. Upper side sorediate in spots ..... (11 g. *P. canina* var. *spuria* f. *sorediata*)
            7. Upper side esorediate.
               8. Veins narrow, strongly raised (caninaeforme); rhizinae simple ..... 6. *P. degenii*.
               8. Veins broad, slightly raised (polydactylaeforme); rhizinae fasciculate ..... 9.
                  9. Apothecia horizontal; spores fusiform 4 celled, 25-45 x 3.5-6 μ ..... 7. *P. horizontalis*.
                  9. Apothecia vertical; spores acicular, 4-10 celled, 48-71 x 3-4.5 μ ..... 8. *P. polydactyla*.
   3. Thallus with tomentum above, at least toward the margins.
      10. Tomentum at margins erect, veins lacking below ..... 9. *P. malacea*.
      10. Tomentum more or less appressed to upper surface; thallus with veins below.
         11. Upper side with scattered peltate isidia ..... 10. *P. lepidophora*.
         11. Upper side lacking isidia or with marginally attached isidia.
            12. Rhizinae simple or fibrillose, upper surface dull ..... 11. *P. canina*.
            12. Rhizinae penicillate, upper surface shining ..... 12. *P. membranacea*.

Sect. 1. PHLEBIA Wallr.

Flora Crypt. Germ. III: 556, 1831.—*Peltidea* Nyl., Acta Soc. Scient. Fennica 8: 594, 1863.—*Peltigera* Sect. Peltidea Wainio, Etud. Lich. Bresil I: 179, 1890, non Duby, nec Fries.—*Chloropeltis* Clements, Genera of Fungi 75, 1909.

Algae of the thallus yellow-green, *Dactylococcus*.

1. PELTIGERA APHTHOSA (L.) Willd.

Flora Berolinensis 347, 1787—*Lichen aphthosus* L., Sp. Pl. 1148, 1753.—*Lichen caninus* var. *aphthosus* Weis., Plant Cryptog. Flora Goettingens. 80, 1770.—*Lichen verrucifer* Gmelin., Syst. Natur. II, Pars II, 1373, 1770.—*Lichen verrucosus* Weber, Spicil. Flora Goettingens. 273, 1778.—*Peltigera amplissima* Hoffm., Deutschl. Flora 106, 1796.

—*Peltidea aphthosa* Ach., Method. Lich. 287, 1803.—*Peltidea aphthosa* var. *verrucosa* Ach., Lich. Univ. 515, 1810.—*Peltidea verrucosa* Röhling, Deutschl. Flora III, 117, 1813. —*Peltigera aphthosa* var. *phymatodes* Wallr., Flora Cryptog. German. III, 560, 1831.—*Peltigera aphthosa* f. *verrucosa* Dietrich, Lichenogr. German., 27, 1832-1837.

Thallus large, sometimes over a meter across, the lobes broad, up to 10 cm. long and 6 cm. broad, although usually smaller, edges ascending. Upper surface smooth in the center with an erect tomentum of hairs 6-8 μ in diameter and up to 65 μ long at the very margin, warty cephalodia containing nostocoid algae 6-9 μ in diameter scattered over the upper surface; pale to apple green when moist, leaden green when dry. Under surface pale at the margins, blackening toward the center of the thallus, either veinless and covered with a fine even nap of tomentum or with white or dark veins, rhizinae scattered, fasciculate. Apothecia large, up to 16 mm. across, on extended lobules, the sides reflexed, the margins becoming crenate, the reverse with a cortex at first, leaving scaly patches of cortex on the back of the larger apothecia; disk reddish-brown to blackish-brown; hypothecium brown; hymenium hyaline to pale brown; paraphyses simple, thickened and darkened at the tips to a red-brown; asci cylindrico-clavate 80 x 12 μ, 8 spored; spores acicular, 3-9 septate, 46-63 x 4-5 μ (Tuckerman reports 48-70 x 4-7; Fink reports 45-75 x 4-7).

Algal layer continuous, 25-35 μ thick; upper part of the cortex pseudoparenchymatous, hyaline to pale brown, 25-55 μ thick; medulla of very loosely interwoven hyphae 10 μ in diameter and with a lumen of 6 μ, hyphae of the veins in var. *variolosa* darker and more thick walled, 12 μ in diameter with a lumen of 4-5 μ, oriented in the direction of the vein; medulla 460-1350 μ thick; rhizoids composed of bundles of hyphae continuous with the medullary hyphae but becoming dark brown, 7μ thick and very thin walled, cellular and anastomosing. Hymenium 80-120 μ thick, hypothecium about 100 μ thick. Algae of thallus 2.5-6 μ diameter; algae of cephalodia 6-9 μ diameter.

Reactions: K minus, C minus, KC minus, P minus, I stains the young asci bright blue, no other part being affected.

On earth, rotting logs and stumps, humus, and rocks, usually in moist places.

Reported from the cool and temperate zones of North America, Asia and Europe. Zahlbruckner in Engler and Prantl vol. 8, p. 191, states it is in the southern hemisphere as well.

Alaska to Newfoundland, south to Arizona, New Mexico, Wisconsin, Tennessee and North Carolina.

KEY TO THE VARIETIES AND FORMS OF PELTIGERA APHTHOSA

1. Underside lacking veins, covered with an even tomentum, bluish or brownish-black at the center, pale white or brownish at the margin .....1a. *P. aphthosa* var. *typica.*
1. Underside veined ..... 2.
2. Veins and interspaces white .....1b. *P. aphthosa* var. *leucophlebia.*
2. Veins brown to black, interspaces pale; center of underside black and margins pale 3
3. Lobes broad, neither auriculate nor crisped .....1c. *P. aphthosa* var. *variolosa.*
3. Lobes either crisped, dilacerate or auriculate.
4. Lobes auriculate .....1d. *P. aphthosa* var. *variolosa* f. *complicata.*
4. Lobes crisped .....1e. *P. aphthosa* var. *variolosa* f. *crispa.*

1a. PELTIGERA APHTHOSA var. TYPICA

Northern and alpine specimens of *P. aphthosa* are more likely to be var. *typica* with the underside covered with a soft, even, brown or bluish-black tomentum, paler at the margins and dark toward the center of the thallus. Because this grades completely into var. *variolosa*, with veined underside, it does not seem reasonable to maintain these as separate species. Southwards var. *typica* is to be looked for in cooler habitats; in bogs, on mountains and in ravines. Lobes measuring up to 10 cm. across have been measured in Alaskan material; in var. *variolosa* the largest lobes were 4 cm. across.

Exsiccatae examined.—Merr. 43 (Y, NY, Mo, Minn, US, Mich); Gyel. 28, 29, sub *P. aphthosa* var. *verrucosa* (Wel); Migula 261, sub *P. variolosa* (C, F); Krypt. Vind. 154 (NY, US, F); Macoun 112 (NY); Wartm. 556 (Minn); Malme 506 (Wis, F).

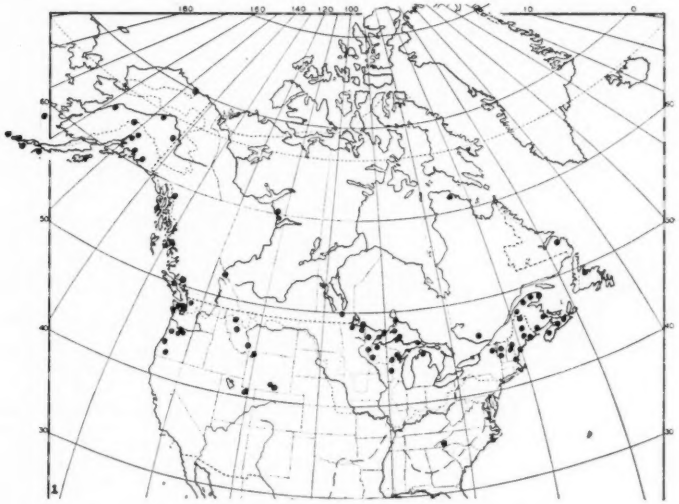

Fig. 1.—*Peltigera aphthosa* (L.) Willd. var *typica*

Specimens examined.—ALASKA: Yakutat Bay at Hidden Glacier Inlet, 1899, *Trelease* (Mo); Yakutat Bay at Port Mulgrave, 1880, *Bean* (C); Kodiak, 1910, *Mylroie* (Wel); 1894, *Bretherton* (US); 1899, *Trelease* (Mo); Sheep Creek, 1891, *Cooley* (Wel); Mt. McKinley Nat'l. Park, 1939, *Nelson* (F, T); 1928, *Mexia* (Minn); Atka Island, 1932, *Eyerdam* (F, DA, Wis); Fairbanks, 1924, *Harshberger* (F); 1926, *Miller* (F); Camden Bay, 1913, *Johnson* (F); St. Paul Island, 1891, (F, P, Mo, NY); 1897, *Macoun* (F); Wrangell, 1913, *Foster* (H); 1899, *Trelease* (Mo); Unalaska Island, 1932, *Eyerdam* (Mich, Wis); Fort Yukon, 1882, *Bates* (P); Yukon River between Nulato and Nowikakat, 1889, *Russell* (US); Fort Cosmos, 1885, *Hough* (US, Mo); Harbor Island, Sitka, 1901, *Fink* (US); Juneau, 1899, *Trelease* (Mo); Shumagin Islands, Popoff Island, 1899, *Saunders* (Mo); Baranoff Island, Hot Springs, 1899, *Trelease* (Mo); Prince William Sound, Orca, 1899, *Trelease* (Mo); Farragut Bay, 1899, *Brewer & Coe* (Mo); Attu, 1894, *Townsend* (Mo); Egg Island, Disenchantment Bay, 1899, *Coville & Kearney* (Mo); Raspberry Island, Kodiak Goup, 1945, *Eyerdam* (Wis); Cantwell, 1926, *Palmer* (T).

NORTHWEST TERRITORIES: British America, *Richardson* (F); Fort Smith, 60° N, 111° 51′ W, 1940, *Dutilly* (Mich).

BRITISH COLUMBIA: Gold Range, 1921; *Plitt* (?) (DA); East of Howsen Lake, 1905, *Shaw* (US); Lowe Inlet, 1899, *Trelease* (Mo); Vancouver Island, 1858, *Lyall* (Wis).

ALBERTA: Fitzgerald, Slave River, 1917, *Brooke & Kindle* (F); Forestry Station, Highwood River District, 1928, *Brinkman* (Mich, DA); Ranger Station, 1928, *Brinkman* (Mich); Banff, 1902, *Platt* (Mich); no date, *Crosby* (Mich).

MANITOBA: Winnipeg, 1925, *Scott* (Mich).

ONTARIO: Emo, 1901, *Fink* (F, US, Minn); Nipigon, 1912, *Jennings & Daily* (F); Oxbow lake west of Algonquin Park, 1941, *Cain* (H); Caribou Island, 1931, *Grassl* (Mich).

QUEBEC: Havre St. Pierre, 1937, *Evans* (Y); 4 miles east of Gaspé, 1929, *Clinton* (Y); Gaspé, 1882, *Macoun* (P); Gaspesie, 1915, *Labrasse* (DA); Riviere-aux-Renards, 1923, *Marie-Victorin* et al. (DA); Wakeham Bay south shore of Hudson Strait, 1936, *Folunin* (F); Point Rouge, 1938, Bro. *Anselm* (H); Matane Co., Riviere Cap Chat, 1923, *Collins & Dodge* (Mich, Mo, NY, D); Temiscouta, no date, *Prat* (DA); Lac Labelle, 1944, *S. M. Thomson* (T).

LABRADOR: no further locality, 1893, *Saarnbarger* (F); Wench, Tuckerman herb (F); Brendel, no date, *Hohenacker* (F); Eagle River, Sandwich Bay, 1893, *Waghorne* (Mo).

NEWFOUNDLAND: St. Anthony, 1937, *Evans* (Y); Band Harbor, St. John's Island Bay, 1925, *Gilbert* (F); Dildo Run, southern shore of Notre Dame Bay, 1911, *Fernald & Wiegand* (F, D, Wel); Eagle River, 1893, *Waghorne* (Minn); Harbor Deep, 1891, *Waghorne* (NY).

NEW BRUNSWICK: Campobello, 1902, *Farlow* (H); Bass River, 1871, *Fowler* (NY).

NOVA SCOTIA: Pictou, 1901, *Howe & Lang* (C, NY); near Digby, 1910, *Macoun* (F); Colchester Co., near Truro, 1924, *Prince* (F, Mich); Jollytown Road, upper Brookside, 1929, *Wehmeyer* (Mich); Sandy Cove, 1908, *Lowe* (DA).

United States. COLORADO: Jones Peak, no date, *Cox* (DA). IDAHO: no locality, 1889, *Leiburg* (US). MAINE: West Pembroke, 1909, *Wiegand* (Wel); Head Harbor, Little Island, 1921, *Norton* (F); Somerset Co., Baker Lake, St. John River, 1917, *Nichols* (F); Piscataquis Co., Katahdin, 1902, *Davis* (Mich); Hancock Co., Mt. Desert Island, 1931, *Plitt* (Mich, DA); 1932, *Plitt* (Mich); Otter Cliffs, Mt. Desert Island, 1933, *Heard* (Mich); Lake Wood, 1928, *Plitt* (DA); Hull's Cove, Mt. Desert Island, 1923, *Plitt* (DA); Otter Cliffs, Mt. Desert Island, 1932, *Plitt* (DA); Cumberland Co., Casco Bay, Orris Island, 1922, *True* (DA); Orono, 1896, *Merrill* (NY). MASSACHUSETTS: Beverly, 1898; no collector data. MICHIGAN: Isle Royale, 1901, *Stuntz & Allen* (Wis, Mich); Mott Island, Isle Royale, 1941, *Bailey* (Mich); Smithwick Island, Isle Royale, 1930, *Povah* (Mich, DA); Blake Point, Isle Royale, 1909, *Cooper* (Minn); Chippewa Co., Sailor's Encampment, 1899, *Harper* (C); Cheboygan Co., Reese's Bog, 1935, *Smith* (Mich); Keweenaw Co., Agate Harbor, 1947, *Thomson* (Wis). MINNESOTA: Cook Co., Grand Portage Island, 1897, *Fink* (F, DA); Grand Marais, 1902, *Fink* (Mich, Minn); Koochiching Co., Rainy Lake City, 1901, *Fink* (Minn); Kettle Falls, 1901, *Fink* (Minn); Roseau Co., Warroad, 1901, *Fink* (Minn); Chisago Co., Taylor's Falls, 1932, *Nielsen* (Minn); Snowbank Lake, 1897, *Fink* (Minn). MONTANA: Gallatin Co., Goose Creek Canyon, Bozeman, 1929, *Young* (Mich); Missoula Co., Missoula, 1932, *Shimangan* (Mich); Lake Co., Flathead Lake, 1899, *Elrod* (Mich); Mission Valley, 1938, *Barkley* (NY); Square Ranger Station, Gallatin River, 1931, *Flint* (DA); Columbia Falls, 1894, *Williams* (DA); Sheep Creek, 1896, *Flodman* (DA, Minn, Mo); Sin-yale-a-min Lake, 1901, *Harris* (NY). NORTH CAROLINA: Mt. Pisgah, 1922, *Schallert* (Wis). NEW HAMPSHIRE: Grafton Co., North Woodstock, Franconia Mts., 1892, Cummings (Wel); Mt. Moosilauke, 1912, *Klingman* (F); Coos Co., Edmonds Trail, Bretton Woods, 1927, *Sudbury* (Y); White Mt. Notch, 1884, *Faxon* (F). NEW YORK: Mt. Marcy, 1933, *Lowe* (Mich); Lake Arnold near Lake Placid, 1933, *Lowe* (F); Ausable Chasm, 1917, *Plitt* (DA). OREGON: Hood River

Co., Cascade Locks, 1933, *Lawrence* (Wel); Woahink Lake, 1940, *Purer* (H); Josephine Co., Rogue River, Union Creek, 1932, *Sipe* (Mich); Union Peak, 1930, *Sipe* (DA); Rhododendron, 1930, *Sipe* (DA); Salem, 1876, *Hall* (US); Multonomah Falls, 1899, *Trelease* (Mo). UTAH: Uintah Mts., 1869, *Watson* (US). VERMONT: Chittenden Co., Mt. Mansfield, 1897, *Sprague* (F); Mt. Mansfield, 1897, *Greenman* (F, Mo); Leicester, 1909, *Dutton* (Mo); Smuggler's Notch, Stowe, 1882, *Knight* (NY). WASHINGTON: Dungeness, 1913, *Foster* (Wel); Clallam Co., Olympic Mts., Elwha River Valley, 1907, *Frye* (Wel); Boulder Peak, 1935, *Smith* (C, Mich); Whatcom Co., Mt. Baker trail, 1914, *Herre* (H, DA); Olympic Hot Springs, 1935 (Mich); Langley, 1921, *Grant* (DA); Gray's Harbor, Pacific Beach, 1911, *Foster* (F). WISCONSIN: the specimens have been previously listed in a paper (Trans. Wis. Acad. 38: 249-272. 1946 (1947)) on that state. WYOMING: Yellowstone National Park, Camp Roosevelt, 1924, *Conard* (F, Mich); Yellowstone National Park, 1922, *Denniston* (F); Yellowstone National Park, 1922, *Hawkins* (Wis); Carbon Co., Medicine Bow Mts., 1903, Goodding (Mich); Centennial Valley, 1895, *Nelson* (Mich, P, DA, D); Albany Co., Douglas Creek, 1903, *Goodding* (US).

1b. PELTIGERA APHTHOSA var. LEUCOPHLEBIA Nyl., Synop. Meth. Lich. I: 323, 1858.

Peltidea aphthosa var. *leucophlebia* Nyl., Notiser ur Sällsk. Fauna et Flora Fennic. Forhandl. 8: 117, 1866.

Nylander describes this variety as being smaller and paler than the typical plant and with "subtus toto albido (nervis distinctis albidis vel pallidis)." In the literature numerous references have been made to this variety but they would appear to be var. *variolosa* which has dark brown veins and the center of the thallus becoming black. Specimens in the Yale herbarium labeled this variety by Gyelnik are typical var. *variolosa*. Without examination of the specimens reported in the literature it is impossible to state the range. Nylander reported it from Sweden and the mountains of France.

Specimens examined.—ALASKA: Prince William Sound, Virgin Bay, 1899, *Trelease* (Mo). United States. OREGON: Rhododendron, Zigzag River, 1935, *Faucett* (Mo).

1c. PELTIGERA APHTHOSA var. VARIOLOSA (Mass.) Thomson, Trans. Wisconsin Acad. Sci. 38: 253, 1947.

Peltigera aphthosa f. *variolosa* Mass., Sched. Crit. III: 64, 1856.—*Peltigera aphthosa* f. *minor* Tuck., Synops. N. A. Lich. I, 106, 1882.—*Peltidea aphthosa* var. *variolosa* Jatta, Syllog. Lich. Ital. 119, 1900.—*Peltigera leucophlebia* f. *variolosa* Gyel., Magy. Bot. Lapok 23: 79, 1925.—*Peltigera leucophlebia* Gyel., Magy. Bot. Lapok 23: 79, 1925.—*Peltidea aphthosa* f. *variolosa* Zahlbr., Cat. Lich. Univ. III: 451, 1925 (lapsus calami).—*Peltigera aphthosa* f. *angustiloba* Fokin et Nikolsk, Trudy Vjästkago gosudarst. Musej. 6, 1926.—*Peltigera variolosa* Gyel., Magy. Bot. Lapok 25: 252, 1927.—*Peltigera variolosa* f. *dactylodes* Gyel., Nyt. Mag. for Naturvid. 68: 269, 1930.—*Peltigera variolosa* var. *leucophlebia* Gyel., Annal. Mycol. 30: 453, 1932.—*Peltigera variolosa* f. *britannica* Gyel., Annal. Mycol. 30: 453, 1932.

This variety is the commonest representative of the species in the United States. The brown to black veins of the underside of the thallus distinguish it from the more northern var. *typica*. Although it has been separated as a distinct species, the range of variation of the plant prohibits such a separation. In any large series of collections the gradation from one variety into the other is so complete that it is often difficult to decide into which category a particular specimen should be placed. According to Gyelnik (Nyt. Mag. f. Naturvid.

68: 269, 1930) who examined the specimen, Fokin and Nikolsk's f. *angustiloba* is the same as his f. *dactylodes*. But this is nothing but material in fruiting condition, a state hardly worthy of nomenclatorial recognition. Examination of the type of f. *minor* in Tuckerman's herbarium proves this to be merely var. *variolosa*.

Exsiccatae examined.—(unless otherwise mentioned these were labeled *P. aphthosa*) Anzi It. 90 (NY); Arn. 1467 sub. var. *variolosa* (Mich); Baker 418 sub. *P. polydactyla* (Mo); Calkins 303 (C); 61 (C) 64 (C) sub. *P. canina* var. *spongiosa;* Cum. I, 160 (Y, Wel, Mo, NY, US, Wis); Cum. II, 92 (F, Mo, C, Minn, Mich); Desm. 1244 (NY); Elenk. 281 (F); Flagey 12 (F); Funck I, 439 (NY); Gyel. 8 sub. *P. variolosa* var. *leucophlebia* (F); Macoun 88 sub. *P. aphthosa* (Wel, NY, US); 131 (US); 112 sub. *P. aphthosa* (Y, NY, Minn, US, Wis); Howe 58 sub. *P. aphthosa* (F, Wel, NY); Mass. 12 (NY); 89 sub. *P. aphthosa* var. *variolosa* (NY); Merr. 43 (F); 53 (Y, C, NY, Mo, DA, Mich, Wis); 401 (F); Mig. 328 sub. *P. aphthosa* (C, NY, F); 68 (NY, Wis, H, Mich, F); Moug. 251 (NY); Mudd 58 (F); Rab. 420 sub. *P. aphthosa* (C, Mich); 159 (Mich); Roum. 313 sub. *P. malacea* (NY); 112 (NY); Roum. Gen. 32 sub. *P. aphthosa* (C); Schaer. 29 (NY); 173 (NY); Stenh. 38 (US); Thoms. 55, 58 (T, Mo, Wis, Mich, NY, DA, F, Wel, H); Tuck. 9 sub. *P. aphthosa* (NY); Wagn. ser. 2, 17 (NY); West. 1355 (NY).

Specimens examined.—ALASKA: Ketchikan, 1925, *Willett* (DA, Wel); Gold Creek, 1891, *Cooley* (US, NY, F); Yakutat Bay, Hidden Glacier Inlet, 1899, *Trelease* (Mo); Baranoff Island, Hot Springs, 1899, *Trelease* (Mo); Prince William Sound, Port Wells, 1899, *Trelease* (Mo); Juneau, 1899, *Setchell* (Mo); Prince William Sound, Orca, 1899, *Trelease* (Mo); Yukon, no date, *Bates* (NY); Mt. McKinley National Park, 1928, *Mexia* (NY, F); Lower Yukon River, Anvik, 1924, *Chapman* (NY); Copper Center, 1933, *Thompson* (Wel); Mt. McKinley National Park, 1939, *Nelson* (F, T); Cantwell, no date, *Palmer* (F); West Dawson, 1902, *Macoun* (F); McDonald Lake region, 1905, *Burcham* (F); Fairbanks, 1926, *Miller* (F); Thum Bay, Knight Island, Prince William Sound, 1932, *Eyerdam* (F, Mich, Wis); Skagway, 1939, *Eyerdam* (F, Mich); Behrings Straits, 1858, *Wright* (F); Unalaska Island, 1897, *Macoun* (F); Atka Island, 1932, *Eyerdam* (Mich); Fort Cosmos, 1885, *Huff* (Mich); St. Paul Island, 1897, *Kincaid?* (Mich).

NORTHWEST TERRITORIES: Great Bear Lake, 1826, *Richardson* (NY, F); West Coast of Hudson Bay, Chesterfield, 1936, *Polunin* (F); Baffin Island, Lake Harbour, 1936, *Polunin* (F); Baffin Island, Panguirtung, 1936, *Polunin* (F); Devon Island, Dundas Harbour, 1936, *Polunin* (F); Ellesmereland, Graasefiord, 1901, *Simmons* (Mich).

BRITISH COLUMBIA: Victoria, 1929, *Mackenzie* (DA); Gold Range, 1921, *no coll.* (DA); near Jordan River, Gold Range, 1914, *Plitt?* (DA); New Westminster, 1903, *Merrill* (F); Vancouver Island, *Lyall* (F); Sidney, Vancouver Island, 1912, *Macoun* (F); Chillimak Lake, 1901, *Macoun* (F); Mt. Edith Cavell, 1917, *Macoun* (F).

ALBERTA: Banff, Sulphur Mt., 1913, *Sanson* (F); also 1910, 1916, *Sanson* (F); Banff, Hot Springs Road, 1910, *Sanson* (F); Fitzgerald, Slave River, 1917, *Brooke & Kindle* (F); Simpson's Pass Summit, Rocky Mt. Park, 1913, *Sanson* (F); Shoal Pass, Alta, 1918, *Macoun* (F); Atawan Cabin, 1929, Brinkman (Mich).

SASKATCHEWAN: no locality, 1859, *Bourgeau* (F).

ONTARIO: Ottawa, 1891, *Macoun* (F, Mo); 1902, *Macoun* (F, Mo); Chelsea, 1907, *Macoun* (F); Porphyry Island, Lake Superior, 1913, *Jennings* (F, DA); Surprise Lake, Silver Islet, 1913, *Jennings* (F); Algoma Co., Montreal Island, 1931, *Grassl* (Mich); Lake Nipigon, 1914, *Jennings* (F); Rossport, 1912, *Jennings & Daily* (F); St. Joseph Island, 1897, *Harper* (C); London, 1888, *Dearners* (NY); Oxylene Lake near Jellicoe, 1917, *Jennings* (DA); Magnetawan Indian Point, 1920, *Plitt* (DA); Cochrane, *Locher* (F, Mich); New Liskeard, *Locher* (Mich); Fort William, 1859, *Hubbard* (Wis); Georgian Bay, Islands off Bruce Peninsula, 1912, *Klugh* (F); Ottawa, *Calkins* (C).

QUEBEC: Gaspé Peninsula, *Thomas* (H); Riviere Romaine, pres du Havre St. Pierre, 1925, Fr. *Marie-Victorin et Rolland-Germain* (Mich); Saguenay Co., Gulf of

Lawrence, Mingan Archipelago, Grand Isle, 1925, Fr. *Marie-Victorin et Rolland- Germain* (Mich); Saguenay Co., Pointe aux Esquimaux, 1924, Fr. *Marie-Victorin et Rolland-Germain* (Mich, DA); La Toque, 1936, Bro. *Anselm* (Y); Waterloo, 1937, Bro. *Anselm* (Y); Port Harrison, 1936, *Polunin* (F); Pilgrim Islands, 1914, *Victorin* (F); Matane Co., Riviere Cap Chat, 1923, *Collins & Dodge* (F, C, NY, D); Hastings Co., no locality, 1869, *Macoun* (F); St. Colomban, 1914, *Victorin* (NY); Pont Rouge, 1938, Bro. *Anselm* (Mo).

LABRADOR: Eagle River, 1893, *Waghorne* (NY, Minn); no locality, 1876, *Hoenacker* (F).

NEWFOUNDLAND: no locality, 1897, *Waghorne* (Mich); Baccalieu, 1902, *Sornbarger* (Mich); Humber Arm, Bay of Islands, Curling, 1929, *Fernald, Long & Fogg* (F); John Beach, Bay of Fundy, 1896, *Waghorne* (Mo, Minn); Bay of Islands, 1901, *Howe & Lang* (C, NY).

NEW BRUNSWICK: Fredericton, 1879, *Fowler* (NY); North Head, Grand Manan, 1922, *Taylor* (DA).

NOVA SCOTIA: Colchester Co., Jollytown Road, Upper Brookside, 1929, *Wehmeyer* (F, Mich); Green Oak, 1929, *Wehmeyer* (Mich); Sandy Cove, 1908, *Lowe* (F); Victoria Co., Big Harbor, 1928, *Prince* (F); Cape Breton Island, Braddock, 1898, *Macoun* (F); Guysboro Co., Westcooks Cove, 1925, *Prince* (Mich); Valley of the Barrasois R., Cape Breton, 1914, *Nichols* (Y, F).

United States. ARIZONA: Thompson's Ranch, Black River, White Mts., 1910, *Goodding* (NY, F); Bonita Creek, White Mts., 1912, *Goodding* (F, US); San Francisco Peaks, 1945, *Darrow* (T). CALIFORNIA: Sisson, 1909, *Pendleton* (Wel, F); Siskiyou Co., Shasta Springs, 1894, *Howe* (NY, US, C, F, H, Mich); Alameda Co., Oakland, no other data (F). COLORADO: Grand Mesa, 1937, *Schillerstrom* (H); Lake Co., Twin Lakes, 1873, *Wolf* (P, NY, US, C, F); Pagosa Peak, 1899, *Baker* (F, NY, Mo); Minnehaha, 1901, *Clements* (F, NY, US, Minn); Pikes Peak, 1919, *Clements* (F); Flank of Mt. Hesperus, 1898, *Baker, Earle & Tracy* (Minn, F, US, Mo); Larimer Co., Beaver Creek Camp, Little Beaver, Tributary of South Fork, Cache La Poudre R., 1896, *Pammel* (Mich, Mo); Rocky Mt. Nat'l. Park, Dream Lake, 1940, *Mains* (Mich); Rocky Mt. Nat'l. Park, Longs Peak Chasm Gorge, 1934, *Kiener* (Mich); Larimer Co., Longs Peak, 1936, *Kiener* (NY, T); Headwaters of Clear Creek and ridges east of Middle Park, 1861, *Parry* (F); James Peak, 1921, *Plitt* (DA); Baltimore, road to Apex, 1929, *Plitt* (DA); vicinity of Pikes Peak, Cheyenne Mts., 1895, *Bessey* (NY); Slum Gullion Pass, Lake City, 1937, *Darrow* (T). CONNECTICUT: West Haven, Allingtown, 1872, *Hall* (Y); West Haven, Maltby Rock, 1873, *Hall* (Y); Fair Haven, 1874, *Hall* (Y); East Rock, New Haven, 1874, *Hall* (Y); Orange, 1873, *Hall* (Y); Beacon Falls, 1884, *Wright* (Y); Glastonbury, *Stormer* (Y); Stamford, 1926, *Evans* (Y); East Hampton, 1927, *Evans* (Y); Guilford, 1932, *Evans* (Y); Middletown, 1882, *Wright* (Y, Mich, F); East Hampton, 1927, *Marshall* (Y); Wintergreen Falls, Hamden, 1927, *Sudbury* (Y); Maltby Park, West Haven, 1921, *Christophersen* (Y); New Haven, 1873, *Eaton* (Y); Cornwall, 1885, *Green* (Mich, NY); Easton, 1893, *Johnson* (C); Beacon Falls, 1884, *Wright* (F); South Glastonbury, 1891, *Wilson* (F); Middlesex Co., East Hampton, 1927, *Evans* (F); Fairfield Co., Stamford, 1926, *Evans* (F); Ellsworth, 1884, *H. A. G.* (US); Plainsville, *Bishop* (C). DISTRICT OF COLUMBIA: 188–, *Lehnert* (US). IDAHO: Priest River, 1914, 1915 (F, DA, Mich); *Weir* (F); Westport, 1908, *Foster* (F); Boundary Co., Rock Creek, 1922, *Wehmeyer* (NY, Mich); Payette National Forest, Big Pine Creek, 1920, *Korstian* (F); Elmore Co., Boise Nat'l. Forest, Atlanta, 1942, *McFadden* (H). MAINE: no locality, 1863, *Blake* (C); Baker Lake, St. John River, 1917, *Nichols* (Y); Rockport, 1904, *Merrill* (NY); Harrison, no other data (NY); Harrison, *Blake* (Mich); Mt. Desert Island, Seal Harbor, 1888, *Redfield* (P); Portage, 1907, *Riddle* (F); Orono, 1907, *Riddle* (F); Mt. Desert Island, Otter Cliffs, 1933, *Heard* (DA); Oakland, 1909, *Plitt* (DA); Norway, *Mann* (US); Oxford Co., Buckfield, 1924, *Parlin* (F); Warren, 1910, Merrill (F); Fort Fairfield, 1893, *Cummings* (F); Dennysville, 1844, *Russell* (F); Kingsfield, 1919, *Norton* (F); Eastbrook, 1922, *Norton* (F): Washington Co., Great Spruce Island, Jonesboro, 1907, *Cushman & Sanford* (F); Flagstaff, 1933, *Dunlap* (Y); Knox Co., Camden, 1936, *Friesner* (T); Haynesville, 1948, *Haring* (Wis). MARYLAND: Montgomery Co.,

Cabin John, 1909, *Miller* (US, Mo); Baltimore Co., Pretty Boy Creek, 1926, *Plitt* (DA, Mich); Baltimore Co., Lock Raven, 1905, *Plitt* (DA); Baltimore Co., Gunpowder near Warren, 1906, *Plitt* (DA); Boiling Spring near Deer Park, 1914, *Plitt* (DA); Powder Mt., West of Hancock, 1940, *Thomson* (T). MASSACHUSETTS: Harvard, 1896, *Moore* (Mo); Alford, *Milligan* (Mo); Weymouth, 1862-1898, *Willey* (US); Weymouth, no other data (C); Schutesbury, 1874, *Tuckerman* (F); Pepperell, 1909, *Teller* (F); Amherst, 1910, *Riddle* (F); Worcester Co., *Russell* (P); Canton, 1884, *Merrill* (P); Clarks Point, New Bedford, 1862-1898, *Willey* (US); Middlesex Co., Concord, 1913, *Howe* (F). MICHIGAN: Keweenaw Co., Eagle River and Copper Harbor, 1947, *Thomson* (Wis); Wagner Falls, Munising, 1933, *Lowe* (DA, Mich, F); Houghton Co., 1892, *Eby* (Mo); Sailor's Encampment, 1898, *Harper* (Mo); Mackinac Island, 1897, *Harper* (C, F); Mackinac Island, 1892, *Wheeler* (F); Sault Ste. Marie, 1897, *Harper* (C); Cheboygan Co., Reese's Bog, 1920, 1923, *Nichols* (Y, F); Isle Royale, McCargoe Cove, 1930, *Lowe* (Mich); Alger Co., Au Train Falls, 1900, *Wheeler* (Mich, F); 1933, *Lowe* (Mich, F); Alma, 1892, *Davis* (Mich); Chatham, 1900, *Wheeler* (F); Isle Royale, 1901, *Stuntz & Allen* (Wis); St. Clair Co., Port Huron, 1897, *Dodge* (Mich); Isle Royale, outlet of Siskowit Lake, 1930, *Lowe* (Mich, F); Isle Royale, Tobin Harbor, 1930, *Lowe* (Mich); Macinac and Chippewa Cos., 1923, *Nichols* (Y); Prentis Bay, 1923, *Nichols* (Mich); Isle Royale, 1868, *University Party* (Mich); Isle Royale, Smithwick Island, 1930, *Povah* (F). MINNESOTA: Grand Portage Island, 1897, *Fink* (Mich, NY); Gunflint, 1897, *Fink* (F); Koochiching, 1901, *Fink* (Minn); Rainy Lake City, 1901, *Fink* (Minn); Harding, 1901, *Fink* (Minn); Beudette, 1901, *Fink* (Minn); Misquah Hills, 1897, *Fink* (Minn); Gunflint, 1897, *Fink* (Minn); Palisades, 1897, *Fink* (Minn); Cook Co., Falls of Cascades R., 1943, *Thomson* (T). MONTANA: Lake Co., Mission Valley, 1938, *Barkley* (C); Flathead Lake, Big Fork, 1908, *Jones* (NY, Mich); Grotto Falls, Middle Creek Canyon, 1902, *Blankinship* (Mich); Gallatin Co., Palisade Falls, Gallatin Forest, 1931, *Whitham* (Mich); Bear Canyon, Bozeman, 1930, *Morris* (Mich); Columbia Falls, 1893, *Williams* (Minn); Gallatin Co., Spanish Basin, 1897, *Rydberg & Bessey* (NY); Missoula, 1898, *Williams & Griffith* (NY); Yellowstone National Park, East DeLacy's Creek, 1897, *Rydberg & Bessey* (NY); Big Fork, 1908, *Clement* (NY); Sheep Creek, 1896, *Flodman* (NY); Hughes Creek, 1904, *Pammel* (Mich); Glacier National Park, Greenwood's Camp, 1910, *Jones* (Mich); Sin-yale-a-min Lake, 1901, *Harris* (Mich); Flathead Lake, 1905, *Bonser* (F). NEW HAMPSHIRE: Tamworth, 1906, *Bartlett* (Mich); Shelbourne, 1882 (F); Shelburne, 1894, *Duggar* (Wis); Tuckerman's Ravine (F); Mt. Washington, 1880, *Thaxter* (F); Mt. Washington, 1889, *U. & C.* (NY); North Woodstock, 1884, *Cummings* (US); 1892, *Cummings* (US); White Mts., *Tuckerman* (F); Warrens, 1906, *Riddle* (F). NEW JERSEY: no locality, Austin (NY); Sussex Co., Kittatinny Mt. west of Harding Lake, 1937, *Torrey* (T). NEW MEXICO: Santa Fe, 1921, *Anect* (F); Santa Fe canon, 1930, Bro. *Arsene* (F); Santa Fe, Lake Peak, 1926, Bro. *Anselm* (F); Colfax Co., Ute Park, 1926, *Standley* (F). NEW YORK: Chapel Pond, Adirondack Mts., 1932, *Lowe* (F, H, Mich); Essex Co., Wadham's Falls, 1886, *Burt* (F); Essex Co., Newcomb, 1920, *House* (F); Jefferson Co., Thousand Island Park, 1902, *Robinson & Maxon* (F, US); Catskill, 1884, *Bainton* (P); Potsdam, 1855, *Ellis* (DA); Penn Yan, 1847, *Sartwell* (F); Penn Yan, *Buckley* (Mo); Jay, 1908, *Riddle* (F); Poughkeepsie, *Gerard* (NY); Washington Co., *Burnham* (NY); Essex Co., Chilson Lake, 1899, *Harris* (NY, Mich, US); Chemung Co., 1893, *Lucy* (NY); Eagle's Eyrie, Lake Placid, 1896, *Britton* (Wel); Ithaca, 1891, *Dudley* (H); Peekskill, *Gerard* (NY); *Fishkill* (NY); Essex Mts. (NY); Essex Co., Lake Champlain, 1886, *Burt* (Mich); Greenwich, 1865, *Fitch* (US); Parker Cabin Hollow near Tuxedo, 1935, *Thomson* (T); Westkill Hollow, Catskill Mts., 1940, *Thomson* (T). NORTH CAROLINA: Winston-Salem, 1922, *Schallert* (F); mountains, no date, *Ravenel* (F); Tryon, *W. E. D.* (F); Buncombe Co., Montreat, 1913, *Standley & Bollman* (F, US); Black Mt., 1899, *Russell* (Mich); Columbus, 1928, *Evans* (Y); Tryon, 1928, *Evans* (F); no locality, Ravenel, labeled Lich. exs. 102 and therefore type of f. *minor*, *Tuck.* (F); Mt. Pisgah, 1922, *Schallert* (C, Mo). OHIO: Clarke Co., Springfield, 1876, *E. j. S.* (O); Belmont Co., 1938, *Yingling* (O); no locality, *Lesquereux* (F). OREGON: Lane Co., Kitson Springs, 1939, *Doty* (H); Mt. Hood, 1907, *Frye* (F, Mich, Wel); Seaside, 1933, *Darrow* (F, Mich); Cala. Valley, 1899, *Barber* (F); Eugene City,

Cusick (F); Eugene, 1933, *Sipe* (Mich); no locality, 1871, *Hall* (F); Still Creek, 1930, *Sipe* (DA); Salem, *Hall* (C); Arthur, 1882, *Howell* (P); Multnomah Falls, 1899, *Trelease* (Mo). PENNSYLVANIA: Wissahickon, near Philadelphia, 1850, *Thaxter* (F); Wissahickon, 1880, *Farlow* (NY); Washington Co., Charleroi, 1905, *Jennings & Klinger* (F); Lancaster Co., McCalls Ferry, 1892, *Heller* (F, US, NY); York Co., York Furnace, 1899, *MacElwee* (P); Chester Co., no locality, 1880, *Rothrock* (C); Franklin Co., Mt. Alto, 1921, *Norris* (DA); Mastic Forge (Lancaster City ?), 1889, *Eby* (Mo); Philadelphia, 1898, *Morris* (NY); Huntingdon Co., Penn. State College Nature Camp, 1937, 1938, *Thomson* (T). RHODE ISLAND: no locality, *Bennett* (Mich). SOUTH DAKOTA: Sylvan Lake, 1927, *Black* (Y); Lawrence Co., Boulder Canyon, 1921, *Ooer* (F); Lawrence Co., Boulder Canyon, Deadwood, 1929, *Palmer* (F). TENNESSEE: no locality, *Calkins* (NY); no locality, 1904, *Moore* (F). UTAH: Uintas, 1869, *Watson* (Y); Dyer Mine, Uinta Mts., 1902, *Goodding* (F, NY, US); ridge between east and west forks (no other data), 1900, *Pammel* (Mich). VERMONT: Hancock, 1928, *Evans* (Y); Newfane, 1935, *Evans* (Y); Charlotte, 1908, *Riddle* (F); Colchester, 1909, *Griffin* (F); Bristol, 1908, *Riddle* (F); Monkton, 1878, *Faxon* (F); Willoughby, 1892, *H. H.* ? (Mich); Mt. Horrid, Rochester, 1921, *Dutton* (C, F); Brattleboro, 1852, *Russell* (C); Brandon, 1886, *Knowlton* (P, US); Pawlet, 1922, *Dodge* (D); Sudbury, 1913, *Dodge* (D); Bellows Falls, 1872, *Willey* (US); Bellows Falls, *Clarke* (F); Brandon, 1912, *Merrill* (F); Brandon, Legion Hill, 1922, *Dutton* (F); Leicester, 1909, 1920, *Dutton* (F); 1922, ... (Mich); Lake Dunmore, 1898, no coll. (F); Athens, 1893, *Howe* (NY); Brookline, 1892, *Grout* (NY); Mt. Mansfield, 1880, *Sprague* (F); Grand View Mountain, 1896, *Burt* (F); Hunt Swamp, Middlebury, 1897, *Burt* (F); Billings Farm, 1919, *Kittridge* (NY). VIRGINIA: Frederick Co., Dehaven, 1932, *Schallert* (H); Monterey, 1935, *Darrow* (Y, Mich, Mo, F); Staunton, 1895, *Murrill* (NY); Smyth Co., east branch of Walker Creek, 1892, *Small* (Minn, US, Mo); Augusta Co., Elliott's Knob, 15 miles west of Staunton, 1942, *Luttrell* (Mo); Madison Co., White Oak Canyon, Shenandoah Nat'l. Park, 1942, *Luttrell* (Mo); Shenandoah Co., Short Mt. near Mt. Jackson, 1942, *Luttrell* (Mo); Giles Co., Cascades Mt. Lake, 1941, *Luttrell & Strickland* (Mo); Albemarle Co., "Sugar Hollow" by Moorsman River, 1940, *Bowden & Strickland* (Mo); Smyth Co., 5 miles north of Konnarock, 1941, *Luttrell* (Mo); Bath Co., Warm Springs, 1941, *Luttrell & Strickland* (Mo); Augusta Co., 7 miles west of West Augusta, 1941, *Luttrell & Strickland* (Mo). WASHINGTON: Langley, 1920, *Grant* (F, D); 1921, *Grant* (Wis); 1923, *Grant* (Wis, D); Marysville, 1924, *Grant* (Mich); Seattle, 1910, *Bardell* (Mo); Seattle, 1910, *Zeller* (Mo); Friday Harbor, San Juan Islands, 1917, *Zeller* (US, NY, Minn); Friday Harbor, 1918, *Herre* (H, T); Friday Harbor, 1906, *Fink* (Wel); Whatcom Co., Mt. Baker, 1919, *Herre* (H); 1914, *Herre* (T); Whidby Island, 1921, *Grant* (F); Indian Canyon, Spokane, 1909, *Bonser* (F); Elwha River valley, Olympic Mts., 1907, *Frye* (F, Mich); Deer Lake Trail, Olympic Mts., 1939, *Smith* (F, Mich, C); Lake Crescent, 1935, *Smith* (F, C, Mich); Olympic Hot Springs, 1935, *Smith* (F, C); Pierce Co., Silver Springs, 1931, *Howard* (F); Mt. Rainier, 1900, *Foster* (F); Mason Co., 1898, *Parker* (Wel); Spokane, 1911, *Bonser* (Wel); Republic, Grosches Canyon, 1912, *Foster* (Wel); *Yakima* Co., Deadhorse Hill, 1931, *Howard* (Wel); Olympic Mts., 1889, *Grant* (F); Mt. Rainier, Ohanapecosh, 1919, *Flett* (NY); Kitsap Co., Mountaineer's Cabin, 1940, *Eyerdam* (Mich); Tenino, Mound Prairie, 1904, *Frye* (Mich). Friday Harbor, Puget Sound, 1906, *Fink* (Mich); King Co., Red Mt., 1942, *Eyerdam* (Wis). WEST VIRGINIA: west of Mt. Pisgah, 1905, *Sheldon* (Mich); no locality, *Calkins* (US, C); Pocahontas Co., Cass, 1939, *Anderson & Brown* (Mo, F); Ridgeville, 1894, *Harper* (Mich, NY); Litlington, 1927, Gray (Mich); Pocahontas Co., Michael Mt., 1922, *Gray* (DA). WISCONSIN: in addition to the specimens cited in the writer's paper on this state the following should be added: Door Co., Ephraim, 1918, *Millspaugh* (C); Brown Co., near Green Bay, *Schuette* (NY, C). WYOMING: Sheridan Co., West Branch of Big Goose R., 1897, *Pammel & Stanton* (Mich); Albany Co., Medicine Bow Mts., 1901, *Nelson* (Mich, US, Mo, NY); Yellowstone Nat'l. Park, Tower Falls, 1899, *Nelson* (US, Mo, NY); Yellowstone Nat'l. Park, Tower Falls, 1922, *Hawkins* (F); Centennial Valley, 1895, *Nelson* (F); Yellowstone Nat'l. Park, Clubman Creek, Yancey, 1902, *Mearns* (Mich); Boulder Creek, Coville Nat'l. Forest, 1914, *Eggleston* (Mich); Albany Co., Douglas Creek, 1903, *Goodding* (Mo, NY).

1d. PELTIGERA APHTHOSA var. VARIOLOSA f. COMPLICATA (Th. Fr.) A. Zahlbr., Cat. Lich. Univ. 3: 451, 1925.

Peltigera aphthosa var. *complicata* Th. Fr., Kgl. Svensk. Vetensk. Akad. Handl. 7: 15, 1867.—*Peltidea aphthosa* f. *complicata* Arn., Flora 67: 232, 1884.—*Peltigera variolosa* f. *complicata* Lynge apud Lynge et Schol., Lich. Northeast Greenland I, 28, 1932.

The lobes are small and auriculate with the veins of var. *variolosa* below. This seems to be an arctic and alpine modification of this species.

On soil.

Reported from Europe and Greenland and in North America from Colorado (Kiener, W. in Bryologist 42: 142-149, 1939).

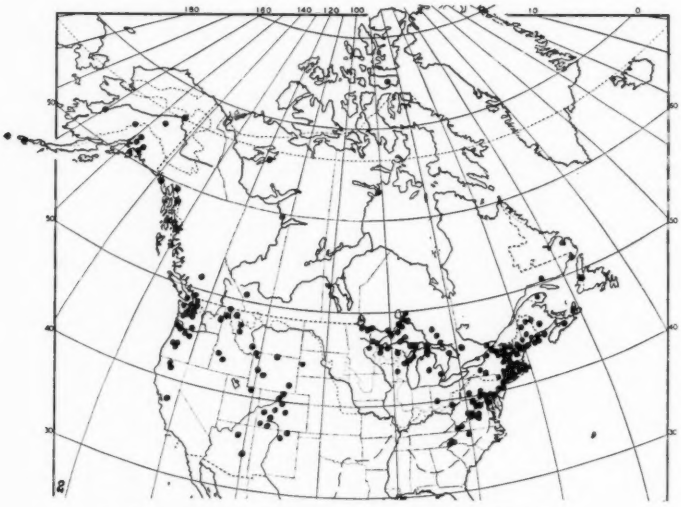

Fig. 2.—*Peltigera aphthosa* (L.) Willd. var. *variolosa* (Mass.) Thoms.

Specimens seen.—NORTHWEST TERRITORIES: Devon Island, Dundas Harbor, 1937, *Polunin* (F); Mansel Island, 1937, *Leechman* (F).

1e. PELTIGERA APHTHOSA var. VARIOLOSA f. CRISPA (Vainio) A. Zahlbr.

Peltidea aphthosa f. *crispa* Vainio, Meddel. Soc. Fauna et Flora Fennica 3: 99, 1878. —*Peltigera aphthosa* f. *crispa*. A. Zahlbr., Cat. Lich. Univ. III: 451, 1925.—*Peltigera variolosa* f. *crispa* Gyel. apud Erichs., Verhandl. des Bot. Verein der Prov. Brandenb. 60: 223, 1928.

In this form the underside is veined as in var. *variolosa* and the margins crisped and curled, usually also being thickened and more or less inrolled. Vainio's original description consisted merely of "thallus margine crispus." Gyelnik made the transfer to *P. variolosa* in an unpublished letter to Erichsen and the assumption must be made that he did so after examining the specimen.

Vainio reported this form from Asia, Erichsen from Europe. It is much more common in North America, occurring sporadically through the range of the species.

Exsiccatae examined.—Thomson 40 (T, Mo, Wis, Mich, NY, DA, F, Wel, H).

Specimens examined.—ALASKA: Fairbanks, no date, *Palmer* (F).

NORTHWEST TERRITORIES: Bay of Awatschka, *Seemann* (NY); mouth of Kogaryuak River, 18 miles east of Coppermine River, Coronation Gulf, 1911, *Anderson* (NY).

ALBERTA: Nordegg River west of Sunbeam Cabin, 1928, *Brinkman* (DA); near Jumping Pound Ranger Station, Morley District, 1928, *Brinkman* (DA).

ONTARIO: Oxylene Lake near Jellicoe, 1917, *Jennings* (DA).

QUEBEC: Matane Co., woods near Mechins-Riviere, Cap Chat, 1923, *Dodge* (D); Matane Co., Mt. Mattaouisse, 1923, *Dodge, Griscom & Pease* (F).

NEWFOUNDLAND: Bay of Islands, 1901, *Howe & Lang* (NY).

United States. COLORADO: Minnehaha, 1901, *Clements* (Mo), 1905, *Clements* (NY); Rocky Mt. Nat'l. Park, Long's Peak, Chasm Gorge, 1934, *Kiener* (Mo). CONNECTICUT: Killingsworth, 1871, *Hall* (Y); 1873, Hall (Y); Wintergreen Falls, Hamden, 1866, *Eaton* (Y); New Haven Co., Kent, 1923, *Evans* (Y, F); *Bethany*, 1925 (Y). DELAWARE: Mt. Cuba, 1890, *Commons* (NY). MICHIGAN: Keweenaw Co., Hebard Park, 1947, *Thomson* (Wis); Macinac or Chippewa Co., Prentis Bay, 1923, *Nichols* (F); Cheboygan Co., Reese's Bog, 1922, *Nichols* (Mich, F, Y); Au Train Falls, 1900, *Wheeler* (F). MINNESOTA: Vermilion Lake, 1886, *Bailey* (F, Minn); Tower, 1901, *Fink* (Minn); Warroad, 1901, *Fink* (Minn); Emo, 1901, *Fink* (Minn); Grand Portage Isle, 1897, *Fink* (Minn); Oak Island, 1901, *Fink* (Minn). NEW JERSEY: Closter, *Austin* (NY). NEW MEXICO: Santa Fe Canyon, 1926, Bro. *Arsene* (F). NEW YORK: Jefferson Co., Thousand Islands Park, 1902, *Robinson & Maxon* (NY). NORTH CAROLINA: Tryon, 1896, *Huger* (NY); Tryon, 1928, *Evans* (Y, D). PENNSYLVANIA: Penn. State College Nature Camp, 1937, *Thomson* (Wis). VERMONT: Bailey's Brook, Newfane, 1935, *Evans* (Y); Monkton, 1927, *Dodge* (D); Starlssboro Bog, 1927, *Dodge* (D); Tadmer Area, Pawlet, 1913, *Dodge* (D). VIRGINIA: Monterey, 1935, *Darrow* (Mo); Smyth Co., Walker Mt., 1892, *Leeming* (NY); Smyth Co., Nick's Creek, 1892, *Leeming* (NY); Natural Bridge, 1921, *Heard* (DA). WASHINGTON: Seguim, 1916, *Grant* (NY). WEST VIRGINIA: Sitlington, 1927, *Gray* (NY); Ridgeville, 1894, *Harper* (C). WISCONSIN: specimen cited in writer's paper (Trans. Wis. Acad. 38: 249-272, 1946 (1947). WYOMING: Yellowstone Nat'l. Park, Tower Falls, 1899, *Nelson* (Minn).

2. PELTIGERA VENOSA (L.) Baumg.

Flora Lipsiens. 581, 1790.—*Lichen venosus* L., Sp. Pl. 1148, 1793.—*Peltidea venosa* Ach., Method. Lich. 282, 1803.

Thallus small, of single, rounded, fan-shaped lobes, sometimes somewhat divided, up to 2 cm. across; flattened. Upper surface smooth, shining, apple green when moist, grayish- or brownish-green when dry. Under surface white or light brown with dark brown or black veins; small dark green or brown to black, warty cephalodia located on the veins and containing nostocoid algae; a single group of rhizoids at one side attaches the thallus to the substrate. Apothecia small, horizontal, up to 5 mm. in diameter, round, borne at the margin of the thallus, the margin crenate, the disk reddish to blackish brown, the reverse with a thick, dark pseudoparenchymatous cortex; hypothecium pale to dark brown with a layer of hyphae inspersed with air immediately below, hymenium hyaline to pale brown, paraphyses simple, coherent, thickened and darkened to a red-brown at the tips; asci cylindrico-clavate, 75 x 11 μ, 8 spored;

spores fusiform, (1-)3 septate (rarely 5 septate), 24-40 x 6-8 μ (Tuckerman reports 30-46 x 7-10; Fink reports 28-45 x 6-9).

Algal layer continuous, 50-65 μ thick; upper part of the cortex pseudoparenchymatous, hyaline to pale brownish, 40-60 μ thick; medulla of very loosely interwoven hyphae 8 μ in diameter with a lumen of 4.5 μ; hyphae of the veins very dark brown, more thickly interwoven, 6 μ in diameter with a lumen of 2.5 μ, medulla 150-300 μ thick; hymenium 100-110 μ thick, hypothecium about 150 μ thick. Algae of thallus 2-3 μ in diameter; algae of cephalodia 4-6 μ diameter.

Reactions: K minus, C minus, KC minus, P minus, I stains algae of thallus blue, other parts negative.

Among mosses on soil and rocks, especially on moist cliff and talus slopes.

Reported from Europe, Arctic Asia, and North America.

Ranges from Alaska to Labrador, south to California, Wyoming, Wisconsin, and Pennsylvania.

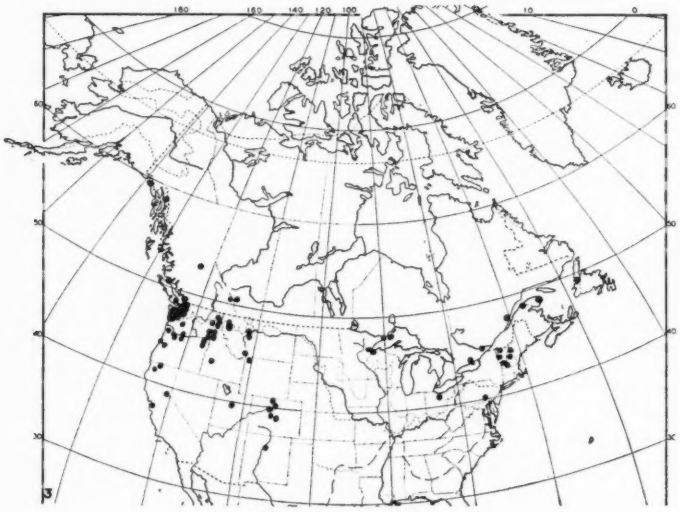

Fig. 3.—*Peltigera venosa* (L.) Baumg.

The distinctiveness of *P. venosa* is evidenced by the very few synonyms given. Räsänen (Annal. Mo. Bot. Gard. 20: 16, 1933) mentions a var. *microcarpa* Räs. from British Columbia, stating "In the dozen individuals from Dorreen the apothecia are much smaller (about 1 mm.) than in the Finnish specimens, so that one might regard the American species as a new variety (var. microcarpa Räs)." No formal description or Latin diagnosis is given. The average range of apothecial size in American material is much larger than Räsänen's single collection, usually several mm. in diameter. But occasionally

small apothecia, especially juvenile stages of development may be interspersed among the larger. To say, on the basis of this one collection, that the American species is a small fruited variety is absurd and unsubstantiated by the large series of other collections. In view of the fact that this falls within the normal range of size of the apothecia and that no satisfactory description is given, this combination has not been recognized.

Exsiccatae examined.—Anzi It. 95 (NY); Arn. 1757 (Minn); Cum. I 63 (F, US, Y, Wel, Wis, Mo, NY); Cum. II. 37 (C, NY, Minn, Mich, Mo); Desm. 731 (NY); Funck I. 17 (C), 115 (NY); Fl. Hung. 211 (F, C); Kern. 1146 (F, US, Minn); Krypt. Bad. 32 a, b, c, (Y); Krypt. Vind. 562 (F, US, NY); Mass. 17 (NY); Mig. 91 (NY, Mich, H, F); Moug. 153 (NY); Macoun 130 (US); 87 (US, Wel, NY, Mo); 34 (US, Y, NY, Minn, Mo, Wis); Rab. 44 (C); 814 (C, NY, Mich); Roum. 36 (C, NY); R. et S. 40 (NY); Schaer. 26 (NY); 172 (F, NY); Stenh. 41 (US); Wagn. 18 (NY); West 814 (NY).

Specimens examined.—ALASKA: Juneau, 1899, *Setchell* (Mo); Hidden Glacier Inlet, 1899, *Trelease* (Mo); Unalaska, 1899, *Setchell* (H); Behrings Straits, 1858, *Wright* (F); Hunker Creek, Klondike, 1902, *Macoun* (F).

BRITISH COLUMBIA: Vancouver, 1858-1859, *Lyall* (F, Wis); no locality, 1875, *Macoun* (F); Quesnelle, 1875, *Hall* (C); Hastings, 1889, *Macoun* (P); North Fork of Canyon Creek, Golden, 1903, *Schantz* (DA); Lat. 54°, *Macoun* (US); Albert Canyon, Selkirk Mts., 1890, *Macoun* (F); Sidney, Vancouver Island, 1912, *Macoun* (F); Colquinte River, Vancouver Island, 1908, *Macoun* (F); Mayan Island, 1904, *Hill* (F); Magni Island, Gulf of Georgia, 1904, *Hill* (F, DA, Mich); Selkirk, 1909, *Bassler* (DA).

ALBERTA: Yagyan, Mirror Lake, 1906, *Fink* (Mich); Banff, 1913, *Sanson* (F); 1920, *Sanson* (F); Summit Simpson Pass, Rocky Mt. Nat'l. Park, 1913, *Sanson* (F); Alta, 1897, *Macoun* (F).

ONTARIO: Ottawa, *Calkins* (C); Hastings Co., 1869, *Macoun* (F).

QUEBEC: Falls of Riviere du Loup, 1877, *Pringle* (F, Wel); Cap a L'Aigle, 1905, *Macoun* (F, Mich); Gaspé, 1882, *Macoun* (P).

LABRADOR: L'Ainse au Clair, 1894, *Waghorne* (Mo, US, Minn, NY).

NEWFOUNDLAND: Bay of Islands, 1901, *Howe & Lang* (NY, C).

United States. CALIFORNIA: McBrides, Mad River, 1896, *Howe* (NY); Sisson, 1909, *Pendleton* (F, Wel); Banks of ditches, Devil's Canyon, Forest Hills, Sierra Nevadas, 1864-1870, *Bolander* (US); San Mateo Co., Old La Honda Road, 1942, *Doty* (H); San Mateo Co., King's Mt., 1930, *Herre* (H); Siskiyou Co., Elliott Creek, 1941, *Doty* (H). COLORADO: Rocky Mt. Nat'l Park, Poudres River, 1937, *Kiener* (Mich, Mo); Lake Moraine, Pikes Peak, 1901, *Cummings* (Wel, F); Minnehaha, 1901, *Clements* (Mo, NY, F); Twin Lakes, 1873, *Wolf* (US, P, NY, C); Minnehaha, north of Manitou, 1903, *Schantz* (DA); Wards beyond Tolland, 1921, *Plitt* (DA); Road to Apex, Baltimore, 1921, *Plitt* (DA); Brookvale, 1918, *Plitt* (DA); Pikes Peak, 1919, *Johnson* (F); Minnehaha, 1903, *Stewart* (F); Butler Canyon, Palmer Lake, 1928, *Gaidig* (F); Boulder Co., Long Lake, 1938, *Kiener* (F, NY, C); Rocky Mts., Lat. 40°, Snowy Range, 1862, *Hall* (C). IDAHO: Lake Pend d'Oreille, 1890, *Luberg* (NY); Nez Perces Co., Lake Waha, 1896, *Heller* (NY, US, Mo, Minn); Latah Co., Beal's Butte, 1901, *Cotton* (F); Priest River, 1914, *Weir* (DA, F); northern Idaho, 1925, *Sipe* (DA); Moscow, 1922, *Stillinger* (DA); shores of Lake PIO, 1891, *Leiberg* (P); Priest Lake, 1910, *Bonser* (Wel); Moscow, 1900, *Abrams* (H); Moscow Mts., Moscow, 1935, *Herre* (H); Elmore Co., Atlanta, 1942, *McFadden* (H); Pend d'Oreille River, 1861, *Lyall* (F). MICHIGAN: Isle Royale, Rock Harbor, 1930, *Lowe* (Mich, DA, F, NY, Wis); Isle Royale, Tobin's, 1930, *Lowe* (Mich). MINNESOTA: Cook Co., falls of Cascade River, 1943, *Thomson* (T); Grand Portage, 1897, *Fink* (US, F, Mich, Minn); Southfowl Lake, 1897, *Fink* (Mich, Minn). MONTANA: Belt Mts., 1891, *Williams* (Minn); Mystic Lake, 1898, *Blankinship* (Mich); Columbia Falls, *Williams* (F); Columbia Falls, 1894, *Williams* (US); Highwood Mts., 1888, *Williams* (US, NY); Gal-

latin Co., Spanish Basin, 1897, *Rydberg & Bessey* (NY); Bridger Mts., 1897, *Rydberg & Bessey* (NY); Big Fork, Flathead Lake, 1901, *Harris* (NY); Tenderfooter, Belt Mts., 1891, *Williams* (NY). NEW HAMPSHIRE: Gorham, *Willey* (US); Plymouth, *Willey* (US); Plymouth, *Hall* (C). NEW MEXICO: Santa Fe, 1848, *Fendler* (F); Santa Fe Canyon, 1930, Bro. *Arsene* (F). OHIO: Lorain Co., Oberlin, 1894, *F. D. Kelsey*. OREGON: Clark's Creek, 3 miles above mouth, 1897, *Sheldon*, (Wel, US); Mt. Hood. 1907, *Frye* (Wel, Mich); Soda Springs, 1899, *Sweetser* (Mo); Eugene, 1899, *Sweetser* (Mo); Portland, 1888, *Underwood* (P, NY); Arthur, 1882, *Howell* (P); Mt. Hood, 1930, *Sipe* (DA); Forest Grove, 1899, *Sweetser* (DA); no locality, 1871, *Hall* (F, C); Portland, 1906, *Foster* (F); Oregon City, 1881, *Pringle* (F); Waldport, *Sipe* (Mich); Eugene, 1936, *Sipe* (H). PENNSYLVANIA: Beartown, 1894, *Eby* (Mo). UTAH: San Pete Co., Cottonwood Creek, Wasatch Plateau, 1938, *Flowers* (H). VERMONT: Athens, 1893, *Howe* (NY); Leicester, 1920, *Dutton* (Wis, F); Lake Dunmore, Leicester, 1920, *Dutton* (Mo); Pittsford, 1921, *Dutton* (C, F, Mich); Jamaica, 1910, *Dobbin* (Mich); Chittenden Co., Colchester, *Russel* (F); no locality, 1851, *Russell* (F); Bakersfield Cliff, *Sprague* (F); Bakersfield Cliffs, 1880, *Pringle* (Wel); Bellows Falls, *Willey* (US); Brattleboro, *Frost* (Y). WASHINGTON: Seattle, 1891, *Parker* (Wel); Olympic Mts., Queets River Valley, 1907, *Frye* (Wel); Asotin Co., Blue Mts., Wenatchee Ranger Station, 1929, *Jones* (Wel); Seattle, campus of state university, 1903, *Frye* (Wel); Port Angeles, 1914, *Foster* (Wel, F); San Juan Island, 1906, *Fink* (DA, NY, F, D); Doebay Road from Olga, Orcas Island, San Juan Co., *Beatty* (DA); Pacific Beach, 1912, *Foster* (DA); Pullman, 1900, *Cotton* (DA); San Juan Islands, Mt. Constitution, 1917, *Zeller* (US, Mo, Minn. NY); Olympia, 1891, *Henderson* (US); Dungeness River, Seguim, 1916, *Grant* (NY); Port Townsend, 1899, *Barber* (F); Pullman, 1913, *Weaver* (F); Klickitat Co., Columbia River, 1881, *Sprague* (F); Horseshoe Lake, 1909, *Bonser* (F); Spokane Co., Deep Creek Canyon, *no coll.* (F); Mt. Rainier, Yakima Park, 1942, *Scholander* (F); Lake Crescent, 1935, *Smith* (F, C, Mich); Olympic Mts., 1915, *Grant* (F); Olympic Mts., 1907, *Frye* (F); Aberdeen, 1908, *Foster* (F); King Co., Richmond Highlands, 1928, *Howard* (F); Marysville, 1922, *Grant* (Mich); Blewitt Pass, Cascade Mts., 1929, *Grant* (Mich); Olympic Mts., Queets River Valley near Hume Glacier. 1907, *Frye* (Mich); Orcas Island, 1906, *Fink* (Mich); San Juan Co., Orcas Island, Mt. Constitution, 1928, *Howard* (Wel); Seattle, 1890, *Parker* (P); San Juan Co., Orcas Island, Olga, *Beatty* (DA); Mt. Rainier, 1904, *Frye* (Mich); Mt. Constitution, 1907, *Cowles* (C, Mo); Langley, 1921, *Grant* (C); Seattle, 1910, *Bardell* (Mo); Seattle, 1910, *Zeller* (Mo); Spokane, *Milburge* (Mo); Bellingham, Schome Hill, 1917, *Herre* (H); Coupeville, 1901, *Gardner* (H); Mt. Baker, 1914, *Herre* (H); King Co., Red Mt., 1942, *Everdam* (Wis). WISCONSIN: the collections have already been cited in the paper by the writer (Trans. Wis. Acad. 38: 249-272. 1946 (1947). WYOMING:: Yellowstone Nat'l. Park, Dunraven Pass, 1932, *Young* (Mich); Grand Canyon of the Yellowstone, 1915, *Smith* (DA).

Sect. II. EMPROSTEA (Ach.) Wainio

Lich. Etud. Bresil., 179, 1890.—*Peltidea* Sect. *Emprostea* Ach. Method. Lich. 282, 1803.—*Dermatodea* St. Hil., Expos. Fam. Natur. 20, 1805 pro p.—*Peltigera* Nyl., Le Naturaliste 6: 387, 1884.—*Peltigera* Sect. *Eupeltigera* Hue, Nouv. Archiv. du Museum, ser. 4, II: 92, 1900.—*Peltigera* Sect. *Peltigerina* Jatta, Syllog. Lich. Ital. 116, 1900.—*Peltigera* subgen. *Peltigera* Boist., Nouv. Flore Lich. 2 part, 80, 1903.—*Peltophora* Clements, The Genera of Fungi 75, 1909.

Algae of the thallus blue-green, nostocoid.

3. PELTIGERA SCUTATA (Dicks.) Duby

Bot. Gallic. II, 599, 1830.—*Lichen scutatus* Dicks., Pl. Crypt. Brit. fasc. 3, 18, 1793 (non Wulf).—*Lichen collinus* Ach., Lichenogr. Suec. Prodr. 162, 1798.—*Peltigera collina* Schrad., Jour. für die Bot. 1: 78, 1801.—*Peltidea scutata* Ach., Meth. Lich. 285, 1803.—*Peltidea rufescens* var. *collina* Ach., Method. Lich. 285, 1803.—*Peltidea scutata* var. *collina* Ach., Lich. Univ. 515, 1810.—*Peltidea collina* Röhling, Deutschl. Flora 3, 2 abth., 116, 1813.—*Lichen scutatus* * *Peltidea collina* Lam., Encycl. Meth. Bot. Suppl. III, 422,

1813.—*Peltidea horizontalis* var. *collina* Wahlb., Flora Suec. II, 842, 1826.—*Peltigera polydactyla* var. *collina* Somerf., Suppl. Flor. Lappon. 124, 1826.—*Peltigera molesta* Del. apud Duby, Bot. Gallic. II, 598, 1830.—*Peltigera scutata* var. *squalida* Duby, Bot. Gallic. II, 599, 1830.—*Peltigera scutata* var. *collina* Duby, Bot. Gallic. II, 598, 1830.—*Peltigera polydactyla* var. *scutata* E. Fr., Lich. Eur. Ref. 47, 1831.—*Peltigera polydactyla* var. *obscurior* Horne, Dansk. Oecon. Plant. II, 510, 1837.—*Peltigera polydactyla* f. *scutata* Torss., Lich. et Byssic. Scand. 8, 1843.—*Peltigera horizontalis* var. *sorediata* Schaer., Enum .Crit. Lich. Europ. 21, 1850.—*Peltigera polydactyla* f. *sorediata* Schaer. loc. cit.—*Peltigera scutata* var. *propagulifera* Fw., 28 Jahresber. Schlesisch. Gesellsch. vaterländ. Kultur, 125, 1850 (nomen nudum).—*Peltigera scutata* var. *genuina* Körb., Syst. Lich. Germ. 60, 1855.—*Peltigera limbata* Del apud Hepp, Flechten Europ. no. 366, 1857.—*Peltigera canina* var. *limbata* Mudd., Manual Brit. Lich. 83, 1861.—*Peltigera canina* var. *scutata* Mudd. loc. cit. 83.—*Peltigera polydactyla* var. *limbata* Nyl., Lich. Scand. 89, 1861.—*Peltigera propagulifera* Stein apud Cohn, Kryptog. Flora von Schleisen II, 2 halfte, 88, 1879.—*Peltigera scutata* var. *limbata* Oliv., Lich. Flor. Orne I, 92, 1882.—*Peltigera Nylanderi* Gyel., Bot. Köz., 24: 137, 1927.—*Peltigera scutata* var. *subscabrosa* Gyel. Bot. Köz. 24: 139, 1927.—*Peltigera scutata* var. *typica* Gyel., Bot. Köz. 24, 138, 1927.—*Pelitgera subscutata* Gyel., Bot. Köz., 24: 139, 1927.—*Peltigera Mauritzii* Gyel., Hedwigia 68: 1, 1928.—*Peltigera scutata* f. *nuda* Gyel., Mag. Bot. Lapok. 28: 61, 1929.—*Peltigera scutata* f. *septentrionalis* Gyel., Mag. Bot. Lapok 27: 93, 1929.—*Peltigera sibirica* Gyel., Mag. Bot. Lapok 28: 61, 1929.—*Peltigera subscutata* var. *spitzbergensis* Gyel., Nyt. Mag. f. Naturvid. 68: 269, 1930.—*Peltigera subscutata* var. *subscutatoides* Gyel., Nyt. Mag. f. Naturvid. 68: 269, 1930.—*Peltigera Mauritzii* var. *asiatica* Gyel., Fedde Repert. 29: 8, 1931.—*Peltigera Mauritzii* var. *dubiosa* Gyel., Fedde Repert. 29: 8, 1931.—*Peltigera Bouly de Lesdainii* Gyel., Rev. Bry. et Lichen. 5: 70, 1932 (nomen nudum).—*Peltigera scutata* f. *alba* Gyel. Ann. Mycol. 30: 453, 1932.

Thallus medium-sized, several cm. across, the lobes about a cm. broad but up to 2 cm. broad, curled and crisped at the edges. Upper side leaden-gray or more commonly brown to chestnut-brown, usually slightly scabrid or pebbly but often smooth, often pruinose-scabrid at the tips of the lobes; the margins usually with large round gray soredia in masses, but these may occasionally be lacking. Under surface malacea-like, lacking veins, or polydactyla-like, the veins tan to chestnut brown or black, the interspaces yellowish-white and cottony; rhizinae short, fasciculate or fibrillose, sometimes forming a dense mass toward the center of the thallus. Apothecia small, up to 3 mm. across, borne at the tips of the lobes, horizontal, or erect and with the sides reflexed, disk chestnut-brown to black, the margins crenate, with a pseudoparenchymatous cortex on the reverse; hypothecium brown, hymenium hyaline below, with a brown pseudoparenchymatous layer above formed by the tips of the paraphyses; paraphyses simple, thickened, darkened and cellular at the tips; asci cylindrico-clavate 80 x 9 μ, 8 spored, the spores often degenerate, acicular, 3-7 septate, 27-64 x 2.5-5.5 μ (Tuckerman reports 50-70 x 3-4, Fink reports 48-68 x 3-4.5).

Algal layer continuous, 25-45 μ thick; upper part of the cortex plechtenchymatous, lower part of this hyaline, the upper part very thick and brown, 40-45 μ thick, medulla of loosely interwoven hyphae 9-10 μ in diameter with a lumen of 5-6 μ, medulla 75-300 μ thick; hymenium 150 μ thick in hyaline part, 60 μ thick in brown part; hypothecium 50-60 μ thick. Algae 4-6 μ in diameter.

Reactions: K minus, C minus, KC minus, P minus, I stains the young asci blue and other parts are negative in reaction.

On bark, rotting logs, and on mossy rocks.

Reported from the northern hemisphere and questionably from Chile in Zahlbruckner's Catalogue. A specimen from Mito, Peru, collected by Dr. George S. Bryan is in the herbarium of the University of Wisconsin. This

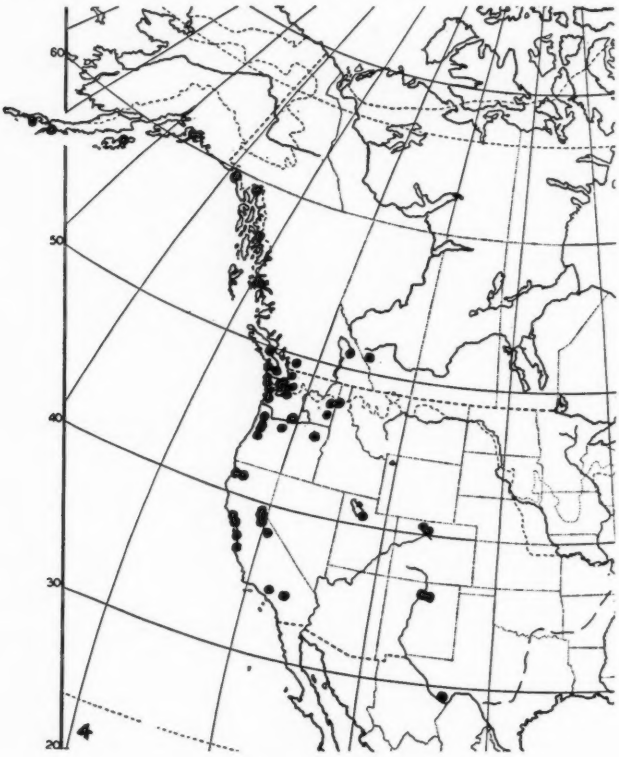

Fig. 4.—*Peltigera scutata* (Dicks.) Duby

species should also be added to the flora of the Hawaiian Islands on the basis of a specimen in the P herbarium (Maui Is., Wailukui, 1880, Thos. Bailey).

The North American range is from Alaska to California, east to Idaho, Colorado and Texas.

Like *Peltigera canina*, this species seems to be very variable; the venation of the underside, the presence or absence of a pruinose surface, the smoothness of the surface, and the amount of the soredia all being inconstant. From the permutations and combinations of such characters Gyelnik has selected groupings which he considered worthy of describing as species or varieties. In any

large series all possible combinations may be found, with parts of the same thallus one entity and parts another if one were to follow the Gyelnik nomenclature. It seems much more reasonable to me to adopt the view that we are here dealing with a very variable plant with the variations being unworthy of nomenclatorial recognition. For this reason I have placed many of the Gyelnik combinations and names in the synonymy; they represent but phases or variations which can be included in the broader species limits which I conceive justified in this case. *Peltigera scutata* has been reported from many states in which it does not occur, the reports being based usually on specimens of regeneration forms of *P. canina* or *P. horizontalis*. Degelius (Ark. f. Bot. 30A, No. 1, p. 8, 1940) has called attention to *Lecidea olivacea* which is found in Europe and western North America and mentioned the occurrence of other plants of different groups with a similar distribution. *Peltigera scutata* can be added to this list.

Exsiccatae examined.—Anzi It. 25 (NY); Arn. 73 (P); Claud. 481 sub *P. limbata* (F); Cum. I. 329 (Y, Mo, NY, Wis); Cum. II. 256 (Y, F, Mich, Mo, NY, C); Krypt. Vind. 868 (US, NY, F); 3149 (NY); 541 (NY); Macoun 91 (US, NY); 134 (US, Mo); Malme 482 (F); Merr. 3 (Y); 245 (Y, US, F, Mich, Minn, C); Moug. 541 (NY); Roum. 35 (NY) sub *P. polydactyla;* 37 (C) sub *P. polydactyla;* 142 (NY); Schaer 366 (NY); 701 (NY); 894 (F), sub *P. limbata.*

Specimens examined.—ALASKA: Cape Fox, 1899, *Trelease* (Mo); Wrangell, 1899, *Trelease* (Mo); Port Vita, Raspberry Island, Kodiak Group, 1945, *Eyerdam* (Wis); King Cove, 1932, *Eyerdam* (Mo, F, Mich); Disenchantment Bay, 1899, *Trelease* (Mo); Yukatat, 1899, *Trelease* (Mo); Skagway, 1939, *Eyerdam* (Mich); Hunker Creek, 1902, *Macoun* (F); Prince William Sound, Orca, 1899, *Trelease* (Mo).

BRITISH COLUMBIA: Vancouver Island, 1859, *Lyall* (F); Fort Yale, 1875, *Macoun* (F); Victoria, Vancouver Island, 1891-1892, *Eckfeldt* (F); 1893, *Macoun* (F); Sidney, 1912, *Macoun* (F); 1913, *Macoun* (F); Elk Lake, 1913, *Macoun* (F): Comox, 1887, *Macoun* (F); Brackendale, 1916, *Macoun* (F); Port Renfrew, *Schneider* (H); Glacier, 1921 (DA); Connors, Vancouver Island, 1887, *Macoun* (P); Lowe Inlet, 1899, *Trelease* (Mo).

ALBERTA: Banff, 1913, *Sanson* (F).

United States. CALIFORNIA: Santa Cruz Mts., Searsville Ridge, 1903, *Herre* (F, H); Lyde Creek, San Bernardino Mts., *Parish* (F); no locality, 1891-2, *Eckfeldt* (F); Santa Cruz Mts., 1885, *Farlow* (F, US); no locality, 1865, *Bolander* (F); 1864, *Bolander* (F); Santa Cruz Mts., Devil's Canyon, 1903, *Herre* (F); Santa Cruz Mts., Black Mt., 1904, *Herre* (F, NY, DA, Mich, H); San Jose, 1880, *Busch* (F, US); San Gabriel Mts., 1897, *Hasse* (F); Humbolt Co., Eureka, 1896, *Howe* (C); Marin Co., 1864, *Bolander* (C); Santa Clara Co., Toyon Lodge, Saratoga, 1945, *Herre & McBride* (C, H, NY); Kneeland Prairie, *Howe* (NY); Sonoma Co., Duncan's Mills, 1896, *Howe* (NY); Los Angeles Co., San Gabriel Range, 1896, *Hasse* (NY); Guadaloupe Island off coast of lower Calif., 1896, *Anthony* (NY); Santa Cruz Mts., Hills west of Stanford Univ., 1903, *Herre* (NY, DA); Olima, 1894, *Howe* (NY); Santa Cruz Mts., Devil's Canyon, 1903, *Herre* (Mo, Minn); Santa Cruz Mts., Los Trancos Creek, 1903, *Herre* (Minn); Santa Cruz Mts., Head of New Grade Road, 1903, *Herre* (Minn, H); Santa Cruz Mts., near Long Bridge, 1907, *Herre* (Minn, DA); Santa Monica Mts., *Hasse* (DA); Santa Cruz Mts., Waddell Creek, Hoover Ranch, 1938, *Herre* (Mich, H); Hastings Reservation, Monterey Co., 1943, 1944, 1942, *Linsdale* (H); El Dorado Co., Fallen Leaf Lake, 1939, *Copeland* (H); Marin Co., Larkspur, 1942, *Brown* (H); Placer Co., Dutch Flat, 1934, *McFadden* (H); Yosemite Valley, 1932, *Herre* (H); Santa Cruz Mts., Saratoga, 1904 *Herre* (H); Santa Cruz Mts., Pilarcitos Canyon, 1903, *Herre* (H); Santa Cruz Mts., between Congress Springs and Low Bridge, 1907, *Herre* (H); Santa Cruz Mts., Fatjo Road, Devil's Canyon, 1903, *Herre* (H); Sonoma Co., Kenwood, 1936, *Goff* (H); Alum Rock Park, 1905, *Herre*

(H); Santa Cruz, 1886, *Anderson* (Mich); Santa Cruz Mts., Hidden Villa Canyon, 1904, *Herre* (Mich, H); Stony Point, Searsville Ridge, 5 miles west of Stanford Univ., 1903, *Herre* (H); San Mateo Co., Skyline Boulevard, Santa Cruz Mts., 1940, *Herre* (H); San Mateo Co., 12 miles west of Stanford Univ., 1940, *Herre* (H); Nevada Co., Laing's Crossing, 1939, *Spurrier* (H); Trinity Co., Carville, *Herre* (H). COLORADO: Rocky Mt. Nat'l. Park, St. Vrain District, 1936, *Kiener* (Mich, Mo); Boulder Co., Cave Creek, middle St. Vrain, 1903, *Herre* (NY); same place, 1938, *Kiener* (C, F). IDAHO: Priest River, 1914, *Weir* (DA, F). NEW MEXICO: Las Vegas, 1929, Bro. *Arsene* (F); Santa Fe Canyon, 1930, Bro. *Arsene* (F). OREGON: Forest Grove, 1898, *Sweetser* (F, Mo); no locality, 1871, *Hall* (F, US); Rhododendron, *Sipe* (DA); Swim, 1930, *Sipe* (DA); Still Creek, 1930, *Sipe* (DA); New Salem, *Hall* (C); Arthur, 1882, *Howell* (P); Corvallis, *Sipe* (Mich); Eugene, 1932, *Sipe* (Mich). TEXAS: Boot Spring, Chisos Mts., 1937, *Warnock* (Mo). UTAH: Salt Lake Co., City Creek Canyon, 1938, *Flowers* (H). WASHINGTON: Bellingham, Chuckanut Mt., 1920, *Herre* (H); Bellingham, *Herre* (H); Whatcom Co., Herre Ranch, 1920, *Herre* (H); Pacific Co., Lake Russell, 1939, *Herre* (H); Whatcom Co., Glacier, Mt. Baker, 1920, *Herre* (H); Olympic Mts., Queets River Valley, 1907, *Frye* (Mich); Cape Flattery, 1935, *Smith* (Mich, C, F); Seattle, 1907, *Frye* (Mich); Seattle, 1891, *Parker* (Wel); Klickitat Co., Goldendale, 1931, *Howard* (Wel, F); Port Angeles, 1914, *Foster* (Wel, F); Gate, 1912, *Foster* (Wel); Langley, 1921, Grant (DA); Pullman, 1899, *Elmer* (F); Seguim, 1915, 1916, *Grant* (F); Pacific Beach, 1910, 1911, *Foster* (F); Spokane Co., 1906, *Bonser* (F, Mo); Aberdeen, 1909, *Foster* (F); Snohomish Co., Mt. Pilchuck district, Gold Basin, 1948, *Eyerdam* (Wis).

4. PELTIGERA EVANSIANA Gyel.—Bryologist 34: 16, 1931.

Thallus small to middle sized up a decimeter across, the lobes up to 3 cm. broad. Upper surface pale gray or brownish-gray or brown, lacking tomentum but scabrid, not smooth or shining, with cylindrical, dark brown, sometimes branched, club-shaped isidia scattered over the surface; the isidia not particularly associated with cracks or breaks in the thallus. Under side pale brownish-white to brown, with a network of light brown to brown, raised, narrow veins and large interspaces; the rhizinae simple, up to 4 mm. long. No apothecia have yet been found for this species.

Algal layer continuous, 40-60 μ thick; upper part of the cortex plectenchymatous, hyaline, 25-50 μ thick, medulla of very loosely interwoven hyphae 4-6 μ in diameter with a lumen of 3.5-4.5 μ, medulla 150-300 μ thick. Algae 3.5-5 μ diameter.

Reactions: K minus, C minus, KC minus, P minus, I minus.

On soil, over mossy rocks, and on the bases of trees.

This is a North American species. The range is from Quebec and Maine to Nebraska, south to Virginia and Missouri.

Although rejected in the Fink "Flora," this is a distinct, well marked species with a northeastern range. Unlike the regeneration forms of the other species of *Peltigera* the isidia in this case are not particularly associated with cracks or other injury to the thallus. They are cylindrical, true isidia, rather than the flattened plates produced by regeneration. In form they resemble such isidia as are characteristic of some of the Collemaceae and Parmelias. Usually this species is found in herbaria confused with and filed under the *Peltigera canina* regeneration form or one of its synonyms such as *P. praetextata.*

Exsiccatae examined.—Thomson 26.

Specimens examined.—QUEBEC: St. Anne, 1935, *Lepage* (D); Rimouski, 1942, *Lepage* (H); Lac Labelle, 1944, *Thomson* (T).

United States. CONNECTICUT: Kent, 1936, *Evans* (Y); Burnham's Brook, East Hartford, 1905, *Weatherby* (Y); Hamden, 1922, *Meyrowitz* (Y, F); Stony Creek, Branford, 1925, *Musch* (Y, F); Barkhamsted, 1933, *Evans* (Y); Canaan, 1936, *Evans* (Y). DISTRICT OF COLUMBIA: 1886, *Lehnert* (P, US). ILLINOIS: LaSalle Co., *Calkins* (US); Champaign Co., 1898, *Clinton* (C). INDIANA: Putnam Co., Greencastle, 1942, *Welch* (H). IOWA: Mahaska Co., Raven Cliffs, 1942, *Conard* (H); Iowa Co., Homestead, 1939, *Kiener* (F, Wis, C, NY); Iowa Co., Iowa River near Amana, 1939, *Kiener* (Y); Emmet Co., Mud Lake, 1917, *Wolden* (DA). MAINE: Oxford Co., Barrell Ledge, South Hartford, 1936, *Parlin* (Y); Orono, 1897, *Fernald* (F). MARYLAND: Baltimore Co., Western Run, 1909, *Plitt* (DA). MASSACHUSETTS: Lanesboro, 1910, *Riddle* (F). MICHIGAN: Keweenaw Co., Manganese River, Copper Harbor, 1947, *Thomson* (Wis); Keweenaw Co., Cliff Mine, 1947, *Thomson* (Wis); Isle Royale, Ryan Island, Siskowit Lake, 1930, *Lowe* (Mich, F); Ann Arbor, Forestry Farm, 1930, *Lowe* (Mich); Deerton, Laughing Whitefish Point, 1933, *Lowe* (Mich); Isle Royale, McCargoe Cove, 1930, *Lowe* (Mich); Au Train Falls, Au Train, 1933, *Lowe* (Mich); Marquette, 1933, *Lowe* (Mich); Pinckney, 1931, *Lowe* (Mich); Emmet Co., Bliss Farm, 1923, *Nichols* (Mich, Y). MISSOURI: Phelps Co., Meramec Spring, 1898, *Trelease* (Mo). NEBRASKA: Weeping Water, 1889, *Williams* (NY). NEW HAMPSHIRE: White Mts., 1843, *Tuckerman* (F); King Ravine Trail, 1927, *Sudbury* (Y). NEW JERSEY: Palisades, 1868, *Austin* (NY). NEW YORK: Clayville, 1906, *Gilbert* (F); Putnam Co., Anthony's Nose Mt., 1940, *Thomson* (T); Putnam Co., between Fahnstock State Park and McKeel's Corners, 1940, *Thomson* (T);

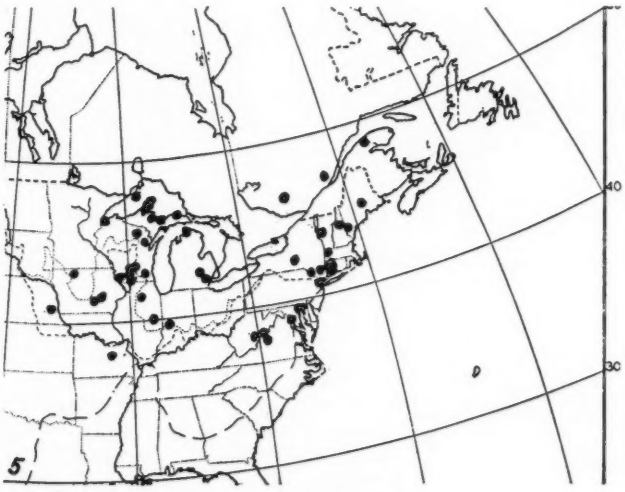

Fig. 5.—*Peltigera evansiana* Gyel.

Arden, 1940, *Thomson* (T). VERMONT: Hancock, 1928, *Evans* (Y); Sudbury, 1913, *Dodge* (D). VIRGINIA: Augusta Co., Reddish Knob, Allegheny Mt., 1940, *Killip* (Mo); Monterey, 1935, *Darrow* (F). WEST VIRGINIA: Seebert, 1929, *Gray* (H). WISCONSIN: a number of specimens have already been cited in the writer's paper (Trans. Wis. Acad. 38: 249-272. 1946 (1947)) on this state.

5. PELTIGERA SCABROSA Th. Fr.

Nova Acta Reg. Soc. Scient. Upsal. ser. 3, III, 145, 1861.—*Peltigera genuina* Gyel. Rev. Bry. et Lich. 5: 70. 1932.—*Peltigera genuina* f. *palmatoides* Gyel., Mag. Bot. Lapok 28: 61, 1929.

Thallus medium sized to large, lobes often large, up to 5 cm. across, although usually smaller. Upper surface greenish-gray or yellowish-brown to brown, dull, scabrid. Under surface with broad flat veins like *P. polydactyla*, the veins brown to blackish-brown, the interspaces white to pale brown, rhizinae fasciculate, sometimes forming a thick mat to the center of the thallus. Apothecia large, up to 6 mm. across, borne on extended lobules, vertical, often round or with the sides reflexed, disk dark reddish-brown, the margin entire to slightly irregular, the reverse with a cortex; hypothecium hyaline to pale brown; hymenium hyaline below, deep brown above; paraphyses simple, thickened and dark red-brown at the tips; asci cylindrico-clavate, 10 x 105 μ, 8 spored; 5-7 septate, spores acicular 63-95 x 2-3 μ (Tuckerman reports 60-94 x 3-4, Fink reports 60-100 x 3-4).

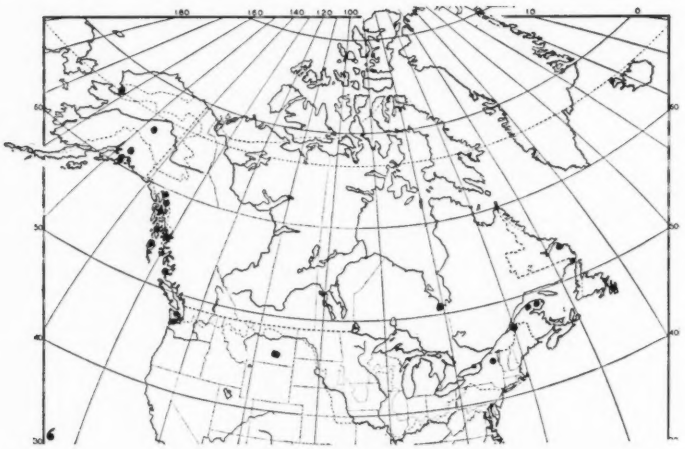

Fig. 6.—*Peltigera scabrosa* Th. Fr.

Algal layer continuous, 40-75 μ thick; upper part of the cortex plectenchymatous, hyaline with the upper part brown, 50-70 μ thick; medulla of loosely interwoven hyphae 11 μ in diameter with a lumen of 4 μ, medulla 50-600 μ thick; hymenium 110-140 μ thick in the hyaline part, 20-25 μ thick in the brown part; hypothecium about 60 μ thick. Algae 6-10 μ in diameter.

On soil and mosses.

An Arctic and arctic-alpine circumpolar species. It ranges from Labrador to Alaska and in the mountains south to Montana and New York (Adirondacks).

Although sometimes placed as a synonym of *P. pulverulenta* (Taylor) Nyl., the latter is a South American species of lichen which I doubt belongs in the *Peltigeras*. I have not seen Taylor's type specimen but the "inferior surface villose as in the Stictaceae," the "apotheciis concavis," and "Thallus suborbicular, flaccid and rugose when wet" do not sound like *Peltigera* characters but more like one of the Collemaceae. Gyelnik has described *Peltigera genuina* f. *minutella* (Mag. Bot. Lapok 28: 61, 1929) with "thallus panniformis" but no mention of locality. I have not found it in North American material. A regeneration form is described below.

Exsiccatae examined.—Fellm. 69 (NY); Krypt. Vind. 2348 (DA, NY); 2452 (NY); Macoun 169 (P); Malme 481 (Wis, F); 683 (Wis); Rab. 914 (Mich, NY, C); Suza 9 (F).

Specimens examined.—ALASKA: Ketchikan, 1925, *Willett* (Wel, DA); Copper Center, 1933, *Thompson* (Wel); Sitka, 1907, *Cowles* (C, Mo); Skagway, 1939, *Eyerdam* (NY, Mo); Thum Bay, Knight Island, Prince William Sound, 1940, 1939, *Eyerdam* (NY, Mo, F); 1939, *Eyerdam* (Mich); Baranoff Island, 1899, *Trelease* (Mo); Deep Cove, Prince of Wales Island, 1939, *Eyerdam* (Mo); Hall Island, Bering Sea, 1899, *Trelease* (Mo); Port Wells, Prince William Sound, 1899, *Trelease* (Mo); Juneau, 1899, *Setchell* (Mo); Farragut Bay, 1899, *Trelease* (Mo); Prince of Wales Island, 1891, *Macoun* (P); False Pass, Unimak Island, 1932, *Eyerdam* (Mich); Deep Cove, Admiralty Island, 1939, *Eyerdam* (Mich, F); St. Michael, 1899, *Setchell* (F); Fairbanks, 1924, *Harshberger* (F); Kotzebue's Sound, 1848, *Babington* (F).

BRITISH COLUMBIA: Swift's Cannery, Hecate Island, 1913, *Foster* (H).

ONTARIO: Moosonee, James Bay, 1943, *Lepage* (H).

QUEBEC: Gaspé Co., Tabletop Mts., 1923, *Dodge* (F, D); Islet a Canuel, Rimouski, 1940, *Lepage* (Mich); St. Anne, 1935, *Lepage* (D).

LABRADOR: L'Ainse au Clair, 1894, *Waghorne* (Mo, Minn, NY, US); Red Bay, 1894, *Waghorne* (Mo, Minn, US); Eagle River, Sandwich Bay, 1893, *Waghorne* (Mo, NY, US).

NEWFOUNDLAND: Highlands of St. John, Yellow Brook Dr. Hill, 1929, *Fernald, Long & Fogg* (F); Corner Brook, 1937, *Evans* (Y); Eagle River, 1893, *Waghorne* (Minn, P); 1894 (P).

United States. MONTANA: Castle Rock, 1904, *Pammel* (Mich). NEW YORK: Adirondack Mts., 1884, *Dudley* (H). WASHINGTON: Boulder Peak, 1935, *Smith* (Mich); Montesano, 1917, *Grant* (DA).

5a. **Peltigera scabrosa** f. **regenerans** Thomson n. f.

Thallus isidiatus ad marginem et ad rimas, ceterum ut in species.

This form has small cylindrical isidia along the borders of the thallus and cracks. The Type specimen is in the U. S. National Herbarium, a duplicate is in the herbarium of the University of Minnesota.

LABRADOR.—Red Bay, July 8, 1894, Rev. *A. C. Waghorne*, no. 57.

6. PELTIGERA DEGENI Gyel.

Magy. Bot. Lapok 25: 253, 1926 (1927).—*Peltigera rufescens* var. *virescens* Steiner apud Penth. et Zederb. in Annal. Naturhist. Hofmuseum Wien 20: 372, 1907.—*Peltigera canina* f. *nitens* And., Hedwigia 65: 79, 1924.—*Peltigera degeni* f. *tasmaniae* Gyel., Magy. Bot. Lapok 28: 61, 1929.—*Peltigera virescens* Gyel., Rev. Bryol. et Lich. 5: 73, 1932.

Thallus medium-sized, the lobes about 2 cm. across. Upper surface smooth,

shining, entirely lacking tomentum, greenish-gray. Under surface with narrow strongly raised veins, the veins light brownish to brown, non penicillate; rhizinae simple, to very slightly fibrillose but not penicillate. Apothecia vertical on extended lobules, the sides reflexed, disk brown to dark reddish-brown; hypothecium pale brown; hyemium hyaline with the upper part dark brown; paraphyses simple, thickened and darkened at the tips to a red-brown; asci cylindrico-clavate, 10 x 80 μ, 8 spored; spores acicular, 5-7 septate, 38-61 x 3-4 μ (spores not reported by Gyelnik).

Algal layer continuous, about 50 μ thick; upper part of the cortex plectenchymatous, hyaline with a light brown upper part, about 30 μ thick; medulla of loosely interwoven hyphae 7 μ thick with a lumen of 4 μ; medulla about 225 μ thick; hymenium with the hyaline part about 110 μ thick, the brown part 40 μ thick; hypothecium about 40 μ thick. Algae 5-8 μ in diameter.

Reactions: K minus, C minus, KC minus, P minus, hyaline part of hymenium staining blue with I, other parts negative.

Gyelnik reports this species from Europe and Japan. I have seen specimens in the Herbarium of the New York Botanical Garden from Bolivia and India (Punjab). In North America it is quite rare, occurring only in the northeast.

This species is quite similar in appearance to *P. membranacea* but the rhizinae are simple to very slightly fibrillose, not in the least penicillate and there is an entire lack of tomentum on the upper surface. Gyelnik's f. *tasmaniae* is merely a fruiting specimen and the name seems unnecessary. The description is written largely from examination of Merrill's exsiccati and other authentic material in the Yale herbarium determined by Gyelnik.

Exsiccatae examined.—Merr. 184 (Y, Minn) (Warren Maine, Aug. 22, 1910).
Specimens examined.—NEW BRUNSWICK: Bartibog Bridge, 1929, *Clinton* (Y). NOVA SCOTIA: Picton, 1937, *Evans* (Y).
United States. VERMONT: Bailey's Brook, Newfane, 1935, *Evans* (Y).

7. PELTIGERA HORIZONTALIS (Huds.) Baumg.

Flora Lipsiens. 562, 1790.—*Lichen horizontalis* Huds., Flora Anglica 543, 1762.—*Lichen horizontalis* var. *nebulosus* Vill., Hist. Plant. Dauphin III, 960, 1789.—*Peltidea horizontalis* Ach., Method. Lich. 288, 1803.—*Peltigera canina* var. *horizontalis* March apud Hall, Vrolik et Mulder, Bijdrag t. d. Naturk. Wetensch 5: 198, 1830.—*Peltigera rufescens* var. *horizontalis* Spreng., Flora Halens., ed 2, 543, 1832.—*Antilyssa horizontalis* Choisy, Atlas Lichenogr. No. 6237, 1927.—*Peltigera horizontalis* f. *lobatoides* Gyel., Magy. Bot. Lapok 28: 61, 1929.

Thallus large, the rounded lobes up to about 3 cm. broad and several cm. long, the margins usually ascending. Upper surface smooth, shining, bluish-gray or greenish gray when moist, lead-gray or brownish-gray or brown when dry, lacking tomentum or cylindrical isidia but sometimes producing tiny flat squamules or "isidia" when regenerating following injury. Under surface with broad flat veins forming an almost confluent tomentum, the veins brown to black, the interspaces white; rhizinae black, sparse, fasciculate. Apothecia horizontal, at the edge of the lobes or on short lobules usually 3-6 mm. across but up to 12 mm., the margin crenate, the disk chestnut brown rarely pruinose, the reverse with scattered patches of cortex; hypothecium pale brown, hymenium hyaline below, brown above; paraphyses simple, thickened and darkened

at the tips; asci cylindrico-clavate, 60 x 10 μ, 8 spored; spores fusiform, 3 septate, 24-45 x 3.5-6 μ (Tuckerman reports 33-46 x 6-8 μ, Fink reports 30-48 x 5-7.5 μ).

Algal layer continuous, 60-80 μ thick; upper part of the cortex plectenchymatous, 40-60 μ thick, hyaline below, grading into pale brown at top; medulla of very loosely interwoven hyphae 12 μ in diameter with a lumen of 9 μ, in the veins the hyphae are dark brown with a diameter of 9 μ, and a lumen of 7 μ, medulla 300-600 μ thick. Hymenium about 80 μ thick; hypothecium about 50 μ thick. Algae 5-9 μ in diameter.

Reactions: K minus, C minus, KC minus, P minus, I turns the young asci blue, other parts are negative.

On soil, fallen logs, stumps and rocks in moist woods.

Reported from the temperate regions of the northern hemisphere.

In North America from the Arctic to Virginia, Mississippi and Colorado.

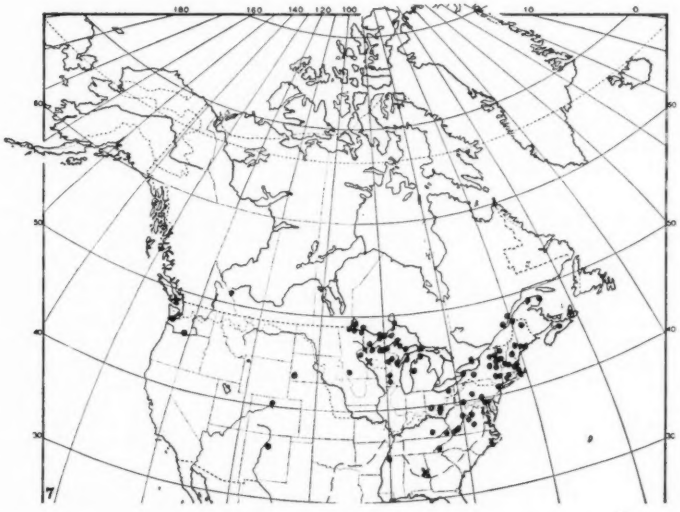

Fig. 7.—*Peltigera horizontalis* (Huds.) Baumg. (solid dots—var. typica, open dots—var. *typica* f. *zopfi* (Gyel.) Thoms., crosses—var. *typica* f. *lacinulata* Gyel., plus sign—var. *ticinensis* DNotrs.)

Many of the specimens in herbaria lack apothecia and without the spores or well developed apothecia *P. polydactyla* var. *typica* and *P. horizontalis* cannot be distinguished. Analogous lacerate and regeneration forms are found in both species so that such specimens when infertile are also indistinguishable. Sterile specimens of *P. polydactyla* var. *dolichorrhiza* can be placed by the simple instead of fasciculate rhizinae.

KEY TO THE VARIETIES AND FORMS OF P. HORIZONTALIS

1. Thallus lacking "isidia" or regeneration lobes.
  2. Lobes short, broad, not linear but may be lacerate.
    3. Lobes not lacerate.
      4. Lobes 1-4 cm. broad, apothecia 2-5 mm. broad ....7a. *P. horizontalis* var. *typica.*
      4. Lobes less than 1 cm. broad, apothecia tiny .....7b. *P. horizontalis* var. *typica* f. *muscorum.*
    3. Lobes lacerate-crisped or crisped.
      5. Disk of apothecium pruinose, margins of the thallus crisped .....7c. *P. horizontalis* var. *pruinosa.*
      5. Disk of apothecium not pruinose, margins lacerate-crisped.....
  2. Lobes long, broadly linear, not lacerate .....7e. *P. horizontalis* var. *ticinensis.*
.....7d. *P. horizontalis* var. *typica* f. *lacinulata.*
1. Thallus with small flat platelets or "isidia" .....7f. *P. horizontalis* var. *typica* f. *zopfi.*

7a. PELTIGERA HORIZONTALIS var. TYPICA

Most of the specimens of *P. horizontalis* fall into a group undistinguished by formal rank and are here called *typica* merely to distinguish them from vars. *pruinosa* and *ticinensis.*

Exsiccatae examined.—Arn. Mon. 388 (Minn); Cum. I. 64 (US, Y, NY, Mo, Mich, Wis); Flagey 163 (F); Krypt. Bad. 256 (Y, C); Krypt. Vind. 1548 (US, Wel, NY, F); Larb. Herb. 249 (NY); Leight. 108 (F, US); Malbr. 115 (F); Malme 585 (Wis, F); Merr. 17 (Y, Mo, Mich, Wis); Moug. 345 (NY); Mudd. 62 (NY, F); Nyl. 33 (F); Rab. 689 (C); Roum. 113 (C); Schaer. 1380 (NY, F); Stenh. 40 (US); Thoms. 56; Tuck. 11 (NY); West. 709 (NY).

Specimens examined.—ALBERTA: Banff, Sulphur Mt., 1913, *Sanson* (F).

NORTHWEST TERRITORIES (?): British America, 1882, *Macoun* (P).

ONTARIO: Hastings Co., Thunder Bay, 1869, *Macoun* (Mo, F); Lake Nipigon, 1884, *Macoun* (US); west of Lake Superior, 1874, *Macoun* (F).

QUEBEC: Cap a L'Aigle, 1905, *Macoun* (F); Montmorency Falls, 1905, *Macoun* (F); Matane Co., Machins-Riviere Cap Chat, 1923, *Dodge* (F, C, NY, D, Mich, Mo); St. Anne, 1935, *Lepage* (D); Gaspé, 1882, *Macoun* (P).

NOVA SCOTIA: Cape Breton Island, 1898, *Macoun* (Mo); Colchester Co., Jollytown Road, 1929, *Wehmeyer* (Mich); Falleigh Lake, 1927, *Prince* (F).

United States. COLORADO: Boulder Co., Cave Creek, Middle St. Vrain, 1938, *Kiener* (F, NY, C); Boulder Co., Fern Cliff, 1938, *Kiener* (NY, T). CONNECTICUT: Killingworth, 1874, *Hall* (Y); Mt. Carmel, Hamden, 1877, *Eaton* (Y, F). KENTUCKY: McCreary Co., Cumberland Falls, 1941, *Allen* (Mo). MAINE: Vienna, 1849, *Oakes* (F); Portage, 1907, *Riddle* (F); Rockland, 1904, *Merrill* (NY); Franklin Co., Farmington, 1929, *Parlin* (DA). MARYLAND: Baltimore Co., Warren, 1906, *Merrill* (F); Baltimore Co., Gunpowder River near Warren, 1926, *Plitt* (DA). MASSACHUSETTS: Waltham, *Tuckerman* (F); Manchester, *Oakes* (F); Boston, Blue Hill, 1882, *Faxon* (F); Wellesley, 1892, *Cummings* (F, US, Mich); New Bedford, *Willey* (Mo, US, Minn); Weymouth, *Clarke* (F). MICHIGAN: Keweenaw Co., Agate Harbor, 1947, *Thomson* (Wis); Keweenaw Co., Copper Harbor, 1947, *Thomson* (Wis); Isle Royale, McCargo Cove, 1930, *Lowe* (F, Mich); Au Train Falls, Au Train, 1933, *Lowe* (F); Emmett & Cheboygan Cos., vicinity of Burt & Douglas Lakes, 1942, *Nichols* (F); Mason Co., Hamlin Lake, Ludington, 1910, *Chaney* (C, NY, US); Sault St. Marie, 1897, *Harper* (C, F); Sailor's Encampment, 1897, *Harper* (C); Isle Royale, 1901, *Stuntz & Allen* (Wis); Isle Royale, Rock Harbor, 1930, *Lowe* (Wis, Mich); Isle Royale, Tobin Harbor, 1930, *Lowe* (Mich, DA); Porcupine Mts., 1922, *Darlington* (Mich); Laughing Whitefish Point, Deerton, 1933, *Lowe* (Mich, DA, NY). MINNESOTA: Falls of Cascades River, Cook Co., 1943, *Thomson* (T); Roosevelt, 1900, *Fink* (US); 1901, *Fink* (DA, Minn, D, F); Duluth, *Kimball* (Mich); Grand Marais, 1902,

Fink (Mich, Minn); Duluth, 1899, *Waldron* (Mich); Redwood Falls, 1899, *Fink* (Minn); Grand Portage Island, 1897, *Fink* (Minn, F); Gunflint, 1897, *Fink* (Minn); Kettle Falls, 1901, *Fink* (Minn); Harding, 1901, *Fink* (Minn); Warroad, 1901, *Fink* (Minn); Oak Island, 1901, *Fink* (Minn); Rainy Lake City, 1901, *Fink* (Minn); Koochiching, 1901, *Fink* (Minn); Emo, 1901, *Fink* (Minn); Beaudette, 1901, Fink (Minn). MISSISSIPPI: De Soto Co., Coldwater, 1938, *Anderson* (Mo). NEW HAMPSHIRE: Chocorua, 1916, *Farlow* (F, C, D, DA); Fitzwilliam, 1850, *Russell* (C); White Mts., 1863, *Mann* (C, US, Y); White Mts., 1844, *Tuckerman* (F); Bartlett, *Oakes* (F); Sutton, 1914, *Riddle* (F); White Mts., Mt. Moriah, 1917, *Taylor* (DA). NEW JERSEY: Closter, *Austin* (NY); Palisades, *Austin* (NY). NEW MEXICO: Santa Fe, 1848, *Fendler* (F); Santa Fe, Monument Rock, 1926, Bro. *Arsene* (F). NEW YORK: Westkill Hollow, Catskill Mts., 1940, *Thomson* (T); Buffalo, *Merrill* (F); Essex Co., Wadham's Falls, 1886, *Burt* (F); Shandaken, 1903, *Miller* (F, Mo, DA); Penn Yan, 1852, *Sartwell* (F); Schenectady, 1843, *Tuckerman* (F); Little Falls, *Peck* (F); Jay, 1908, *Riddle* (F); Herkimer Co., coll. illegible (NY); Lake George, Hulett's Landing, 1890, *Jelliffe* (P); Adirondack Mts., Chapel Pond, 1932, *Lowe* (Mich). NORTH CAROLINA: Eagle's Nest near Waynesville, 1910, *Standley* (F, US); Waynesville, 1910, *Standley* (F). OHIO: Sugar Grove, 1892, *Werner* (F); Fairfield Co., Sugar Grove, 1892, *Bogue* (NY); no locality or date, *Lesquerux* (F); Fairfield Co., 1935, *Wolfe* (O, Wolfe); Hocking Co., Neotoma, 1935, *Wolfe* (O, Wolfe); Lake Co., Painesville, 1892, *Werner* (O, NY); Adams Co., 1900, *W.A.K.* (O). PENNSYLVANIA: Huntingdon Co., Penn. State College Nature Camp, 1938, *Thomson* (T); Fayette Co., 1905, *Jennings* (F); Lancaster Co., McCall's Ferry, 1892, *Heller* (F). TENNESSEE: Lookout Mt., *Calkins* (Mich). VERMONT: Lake Dunmore, 1896, *no collector* (F); Brandon, 1922, *Dutton* (Mo, Mich); Lake Dunmore, 1896, *Fley* (Mo); Fairlee, Eagle Bluff, 1927, *Mathias* (Mo); Brattleboro, 1851, *Russell* (C); Region Falls Hill, Sherburne, 1921, *Dutton* (C); Brattleboro, *Frost* (C, Y); Lake Dunmore, 1896, *Farlow* (Y); Hancock, 1928, *Evans* (Y); Bailey's Brook, Newfane, 1935, *Evans* (Y); Newfane, 1893, *Howe* (NY). VIRGINIA: Norton, 1891, *Seymour* (F); Shenandoah Co., Devil's Hole Mt., 1938, *Allard* (US, NY); Augusta Co., West Augusta, 1941, *Luttrell & Strickland* (Mo); Smyth Co., Konnarock, 1941, *Luttrell & Strickland* (Mo); Louisa Co., Boswell Tavern, 1941, *Luttrell & Strickland* (Mo); Giles Co., Mt. Lake, 1941, *Luttrell & Strickland* (Mo). WASHINGTON: Goldendale, *Foster* (F); Cascades to Fort Coville, 49° N. Lat., 1860, *Lyall* (F); Aberdeen, 1908, *Foster* (F). WEST VIRGINIA: Huntersville, 1930, *Gray* (DA, Mich); Sitling, Dunmore, 1927, *Gray* (F, H); no locality, *Calkins* (C); Lick Run, 1904, *Sheldon* (F). WISCONSIN: to the specimens already cited from this state in the writer's paper (Trans. Wis. Acad. 38: 249-272) should be added: DOOR CO., Washington Island, Detroit Harbor, 1897, *Burrill* (C).

7b. PELTIGERA HORIZONTALIS var. TYPICA f. MUSCORUM (Schleich.) A. Zahlbr., Cat. Lich. Univ. III: 471, 1925

Peltigera muscorum Schleich. 1823.
Peltigera horizontalis var. *muscorum* Schaer. Lich. Helvet. Spicil., Sect. 5, 265, 1833.

The only description given by Schaerer is "omnibus partibus minor" in citing Schleicher's species under a varietal category. The transfer to the formal rank seems to have been an error in the *Zahlbruckner Catalogus*. This is but a small variant of the species and should be given at most the rank of form.

Specimens seen.—United States. OHIO: no locality, 1876, *Biddlecombe* (F). SOUTH CAROLINA: Hogback Mt., 1929, *Evans* (Y).

7c. PELTIGERA HORIZONTALIS var. PRUINOSA Gyel., Oestr. Bot. Zeitschr. 77: 226, 1928

This variety is described as being with the disk of the apothecium pruinose and the margin of the thallus crisped, otherwise being like the typical *P. hori-*

zontalis. Gyelnik cites Arctic America as the place of collection with no other data on locality. The Type is at Kew, I have seen no specimen but include it here on the basis of the description by Gyelnik.

7d. PELTIGERA HORIZONTALIS var. TYPICA f. LACINULATA Gyel., Magy. Bot. Lapok 28: 61, 1929

The only description given by Gyelnik consists of "margine dilaceratocrispo." We must assume that the characters otherwise are as for the species. No specimen is cited. Specimens with such a dilacerate crisped margin are cited below:

QUEBEC: Bic Co., Rimouski, 1940, *Lepage* (Mich); Gaspé, *Macoun* (F).

United States. ALABAMA: Goldville, 1900, *Pollard & Maxon* (F). MINNESOTA: Palisades, 1897, *Fink* (Minn). WISCONSIN: Polk Co., St. Croix Falls, 1897, *Baker* (NY).

7e. PELTIGERA HORIZONTALIS var. TICINENSIS Notrs., Memor. R. Acad. Sc. Torino, ser. 2, vol. 12: 131, 1851

Peltigera ticinensis Jatta, Sylloge Lich. Ital., 118, 1900.—*Peltigera horizontalis* f. *ticinensis* A. Zahlbr., Cat. Lich. Univ. III, 471, 1925.

The diagnostic characters of this variety are a small thallus with broad, linear lobes. It was described from Italy.

Specimens seen.—BRITISH COLUMBIA: Vancouver Island, 1858-1859, *Lyall* (F).

7f. PELTIGERA HORIZONTALIS var. TYPICA f. ZOPFI. (Gyel.) Thomson, Trans. Wis. Acad. 38: 256, 1947

Peltigera Zopfi Gyel., Bot. Köz. 24: 134, 1927.

This is the isidiate or regeneration form of *P. horizontalis*.

Exsiccatae examined.—Merr. 280 (US); 17 (C, NY, DA) (in most examples this number is var. *typica*). Thomson 53 (noted as being either this or *P. polydactyla* f. *microphylla*); Tuck. 12 sub *P. horizontalis* (NY).

Specimens seen.—Only fruiting specimens are listed in order to avoid confusion with the corresponding regeneration form of *P. polydactyla*.

ONTARIO: Battersea, 1898, Fowler (F).

QUEBEC: St. Anne, 1935, Lepage (D).

United States. MASSACHUSETTS: Lunnenberg, 1883, *Sargent* (F); Natick, 1908, *Riddle* (F); Wellesley, 1892, *Cummings* (Wel). MICHIGAN: Keweenaw Co., Copper Harbor, 1947, *Thomson* (Wis); Emmet & Cheboygan Co., Island, Burt & Douglas Lakes, 1922, *Nichols* (Y). MINNESOTA: northwest Minnesota, 1900, *Fink* (F, Minn); Thief River Falls, 1900, *Fink* (Minn); Gunflint, 1897, *Fink* (Minn); Tofte, 1897, *Fink* (Minn); Bemidji, 1900, *Fink* (Minn); Warroad, 1901, *Fink* (Minn); Beudette, 1901, *Fink* (Minn). NORTH CAROLINA: Crowders Mt., 1886, *Green* (NY). OHIO: Clifton, 1876, *Bogue* (O). SOUTH DAKOTA: Black Hills, 1859, *Hayden* (F). VERMONT: Hancock, 1928, *Evans* (Y).

8. PELTIGERA POLYDACTYLA (Neck.) Hoffm.

Descript. et Adumbr. Plant. Lich. I, 19, 1790.—*Lichen polydactylon* Neck., Method. Muscor. 85, 1771.—*Lichen caninus* var. *polydactylon* Lightf., Flora Scotica II, 846, 1777.—*Lichen caninus* var. *pellucidus* Weber, Spicil. Flora Goettingens., 270, 1778.—*Peltigera polydactylon* Hoffm., Descript. et Adumbr. Plant. Lich. I, 19, 1790.—*Peltidea polydactyla* Ach., Method. Lich., 286, 1803.—*Peltidea polydactyla* var. *pellucida* Ach., Method.

Lich. 287, 1803.—*Peltidea hymenina* Ach., Method. Lich. 284, 1803.—*Peltidea glauca* Pers. apud Ach., Lich. Univ. 518, 1810.—*Peltidea pellucida* S. Gray, A Natur. Arrang. Brit. Plants I, 429, 1821.—*Peltidea horizontalis* var. *hymenina* Ach., Synops. Lich. 238, 1814.—*Peltigera canina* var. *attenuata* March apud Hall, Vrolik et Mulder, Bijdrag t. d. Natuurk. Wetensch. 5: 198, 1830.—*Peltigera hymenina* Del. apud Duby, Bot. Gallic II, 597, 1830.—*Peltigera polydactyla* f. *pellucida* Dietrich, Lichenogr. Germ. 27, 1832-37.—*Peltigera rufescens* var. *polydactyla* Torss., Enumer. Lich. et Byssac. Scand. 8, 1843.—*Peltigera polydactyla* var. *vulgaris* Körb., Syst. Lich. Germ. 61, 1855.—*Peltigera canina* var. *coriacea* f. *polydactyla* Krmphbr., Denkschrift Kgl. Bayer. Bot. Gesell. 4: 2 abth., 124, 1861.—*Peltigera canina* var. *polydactyla* Branth. et Rostr., Bot. Tidssk. 3: 175, 1869.—*Peltigera magyarica* Gyel., Magy. Bot. Lapok 28: 61, 1929.

Thallus variable, ranging in size from single, pusilloid erect lobes to large thalli almost a meter across; the lobes imbricate, up to 4 cm. across and several cm. long, the margins ascending, some forms crisped or proliferate. Upper surface dark greenish-blue when moist, slaty or bluish or greenish-gray or brownish when dry, smooth, shining. Under surface with broad, flat, white, or usually, brown or black, reticulated veins with very small white interspaces, rhizoids sparse, short and fasciculate or in one variety over 5 mm. long and simple. Apothecia medium sized, 2-5 mm. in diameter, on erect narrow lobules at the ascendent tips of the lobes, sometimes borne in pairs, the sides usually reflexed, the disk reddish or chestnut brown to black, the margin crenate, the reverse corticate; hypothecium brown, hymenium hyaline, asci cylindrico-clavate, 80-105 x 10 μ, 8 spored; the spores acicular, slightly curved, 48-105 x 3-4 μ (Tuckerman reports 69-90 x 3-4; Fing reports 60-100 x 3-4).

Algal layer continuous, 20-30 μ thick; upper part of the cortex plectenchymatous 30 μ thick, hyaline to pale brown, medulla of very loosely interwoven hyphae 8 μ in diameter with a lumen of 5 μ; medulla 200-700 μ thick. Hymenium 100-110 μ thick; hypothecium about 60 μ thick. Algae 3-6 μ in diameter.

Reactions: K minus, C minus, KC minus, P minus, I stains the asci blue, no other part being affected.

On soil, moss, logs, rocks and bases of trees in moist woods.

Reported to be cosmopolitan..

Ranges throughout North America.

KEY TO THE VARIETIES AND FORMS OF P. POLYDACTYLA

1. Rhizinae fasciculate.
   2. Underside with broad, flat veins, interspaces conspicuous ..... 8a. *P. polydactyla* var. *typica.*
      3. Thallus more than 1 cm. across the lobes, apothecia over 2 mm. long.
         4. Neither lacerate nor isidiate ..... 8a. *P. polydactyla* var. *typica.*
         4. With isidia or lacerate margins.
            5. Thallus with tiny proliferations or isidia on the margins and along cracks and injuries on the upper surface ..... 8b. *P. polydactyla* f. *microphylla.*
            5. Thallus lacking isidia but with the margins lacerate to lacerate-crisped ..... 8c. *P. polydactyla* f. *lophyra.*
      3. Thallus less than 1 cm. across the lobes, apothecia 2 mm. or less long ..... 8d. *P. polydactyla* f. *microcarpa.*
   2. Underside almost uniform, interspaces very inconspicuous ..... 8e. *P. polydactyla* var. *crassoides.*
1. Rhizinae simple ..... 8f. *P. polydactyla* var. *dolichorrhiza.*

8a. PELTIGERA POLYDACTYLA var. TYPICA

Most of the collections of *Peltigera polydactyla* fall into this group. It does not seem necessary to distinguish by names such trivial variations as two apothecia on a lobule instead of the more frequent single apothecium (*P. pellucida* Ach., and subsequent combinations of this name), nor the small pusilloid lobes instead of the more frequent imbricated lobes (*P. magyarica* Gyel.). Gyelnik (Magy. Bot. Lapok 29: 51, 1930) has already shown by examination of the type specimens that *Peltidea hymenina* of Ach. is merely typical material and renamed the variety or form *hymenina* of authors var. *crassoides*.

Exsiccata examined.—Anzi It. 94 (NY); Arn. 340 (Minn); 1030 (Minn); Bohl. 71 (NY); Cum I. 17 (US, Wel, NY, Mo, P, Mich, Wis, F); 359 (Mo); sub *P. canina* var. *membranacea;* Fellm. 71 (NY); Flagey II 162 (F); Kern. 1948 (Minn); Krypt. Vind. 661 (US, NY); Macoun 82 (Mich) sub *P. rufescens;* 89 (US) sub *P. horizontalis;* 94 (Wel) sub *P. membranacea;* 114 (NY, Wis); Malme 484 (Wis, F); Mass. 260 (NY); Merr. 3 (F, US, Mich) sub *P. membranacea;* 184 (F) sub *P. canina;* Moug. 633 (NY); Mudd 61 (NY, F); Rab 421b (C) sub *P. pusilla;* 359 (C, Mich); Rel. Tuck. 74 (Wel); Roum. 34 (C); 314 (NY); R. & S. 117 (NY); Stenh. 65 (US); Thoms. 51; Tuck. 10 (NY).

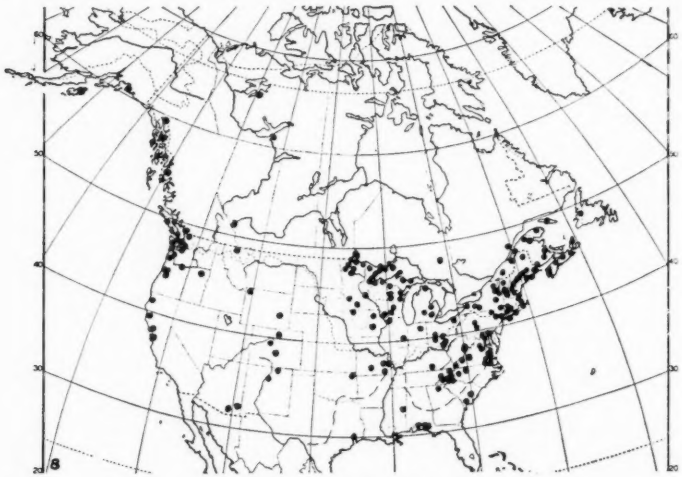

Fig. 8.—*Peltigera polydactyla* (Neck.) Hoffm. var. *typica*

Specimens examined.—ALASKA: Windfall Harbor, Admiralty Island, 1907, *Stephens,* (H); Prince of Wales Island, 1913, *Herre* (H); Orca, Prince William Sound, 1937, *Norberg* (Mich, F); 1899, *Trelease* (Mo); Hinchinbrook Island, 1937, *Norberg* (Mich, F); Kodiak, Kodiak Island, *Eyerdam* (DA); Sitka, Baranoff Island, 1899, *Trelease* (Mo); Sitka, 1899, *Setchell* (Mo); Faragut Bay, 1899, *Coville & Kearney* (Mo); Cordova, 1933, *Thomson* (Wel); Prince William Sound, 1891, *Hayes* (Wel); Skagaway, 1939, *Eyerdam* (Wis).

NORTHWEST TERRITORIES: Great Slave Lake, 1826, *Richardson* (NY); Great Bear Lake, 1826, *Richardson* (F).

BRITISH COLUMBIA: Sidney, Vancouver Island, 1916, *Macoun* (F); New West-

minster, 1902, *Macoun* (F); 1903, *Merrill* (F); 1902, *Hill* (F); Springfield, *Macoun* (F); Veluvet, Vancouver Island, 1909, *Macoun* (F, Mo); west coast of Vancouver Island, 1909, *Macoun* (F); Brackendale, 1916, *Macoun* (F); Lowe Inlet, 1899, *Coville & Kearney* (Mo); Port Renfrew, 1901, *Crosby* (Mich); Port Renfrew, *Schneider* (H); Connox, Vancouver Island, 1887, *Macoun* (NY).

ALBERTA: Banff, 1916, *Sanson* (F).

SASKATCHEWAN: no locality, 1859, *Bourgeau* (F).

ONTARIO: Cochrane, *Locher* (Mich); Rabbit Mt., 3 mi. southeast of Stanley, 1913, *Jennings* (DA, F); La Canadienne Pt., Thunder Bay Co., 1931, *Grassl* (Mich); no locality, 1885 *Macoun* (F).

QUEBEC: Anticosti, Riviere Vaureal, 1925, *Victorin & Rolland-Germain* (Mich); Anticosti Riviere a la Patate, 1925, *Victorin & Rolland-Germain* (Mich); St. Moise, Matapedia, 1934, *Lepage* (Mich); Mt. Shefford, Waterloo, 1936, *Anselm* (Y, H); Gaspé, 1882, *Macoun* (P); St. Anne, 1935, *Lepage* (D, H); Beauceville, 1939, *Anselm* (Mo); Chicoutimi Co., Lac Rouge, Kenogami, 1941, *Allyre* (H); Temiscouta Co., Mt. Wissick, 1942, *Lepage* (H); Havre St. Pierre, 1937, *Evans* (Y).

LABRADOR: Captain Island, 1884, *Waghorne* (Minn); Cafelan Island, 1896, *Waghorne* (US).

NEWFOUNDLAND: Bay of Islands, 1895, *Waghorne* (Minn); Frenchman's Cove, Bay of Islands, 1895, *Waghorne* (Minn, Mo); St. Anthony, 1937, *Evans* (Y); Capstain Island, 1894, *Waghorne* (P); Deer Lake, Bay of Islands, 1895, *Waghorne* (Mo).

NEW BRUNSWICK: New Galloway, Glenlee, *McAndrew* (Mich); Campobello, 1902, *Farlow*, (C); Fredericton, 1879, *Fowler* (NY).

NOVA SCOTIA: Cape Breton Island, Barrasois River, 1914, *Nichols* (F, Y); Sandy Cove, 1908, *Lowe* (DA, F); Colchester Co., Folly Lake Road, *Wehmeyer* (Mich); Colchester Co., East Mt., *Wehmeyer* (Mich); Guysboro Co., Westcooks Cove, 1925, *Prince* (Mich); Colchester Co., East Mt., 1928, *Prince* (F); Kentville, 1928, *Prince* (F); Folleigh Lake Region, 1927, *Prince* (F); Yarmouth, 1910, *Macoun* (F); Cape Breton Island, 1898, *Macoun* (F); Yarmouth, 1901, *Lowe & Lang* (NY).

United States. ALABAMA: Lee Co., Auburn, 1897, *Earle & Baker* (NY, Mich, C); no locality, 1892, *Sarnbarger* (F). ARIZONA: Monument Peak, Chiricahua Mts., 1906, *Blumer* (US); Huachuca Mts., Carr Peak, 1909, *Goodding* (F, NY). CALIFORNIA: Mendocino Co., 1896, *Howe* (NY); Humboldt Bay, 1864, *Bolander* (Mich); Minion Dolores, 1884, *Lehnert* (P); Marin Co., *Bolander* (Y, US); Humboldt Co., Eureka, 1896, *Howe* (NY); Arcata, 1936, *Howe* (H); Santa Cruz Mts., between Congress Springs and Long Bridge, 1907, *Herre* (Mo); Marin Co., at the paper Mill, *Bolander* (US); no locality, *Bolander* (F). COLORADO: Twin Lakes, 1873, *Wolf* (US, NY, F, P, C); Boulder Co., South St. Vrain Canyon, 1938, *Kiener* (NY, C); Custer Co., South Colony Creek, 1941, *Kiener* (C). CONNECTICUT: West Goshen, 1889, *U.E.C.* (NY); New Haven Co., New Haven, 1873, *Eaton* (F); Middleton, 1880, *Wright* (Y); 1883, *Wright* (F); Goshen, 1890, *Underwood* (P); New Haven, *Setchell* (F); Goshen, 1884, *Wright* (C, F); Devil's Hop Yard State Park, 1936, *Taylor* (Mich); Fairfield Co., Stamford, 1926, *Evans* (F); Wethersfield, 1882, *Wright* (F). DISTRICT OF COLUMBIA, no date, *Lehnert* (Mich). FLORIDA: Gadsden Co., Quincy, 1895, *Nash* (NY, F, US, Mo); Talahassee, 1891, *no collector* (F); Monticello, *Lighthipe* (NY); no locality, 1848, *Chapman* (F). GEORGIA: Brasstown Ball Mt., 1927, *Miller* (Mich). ILLINOIS: Savanna, *Clinton* (C); Urbana, 1898, *Clinton* (C). INDIANA: Wells Co., Kingsland, 1914, *Deam* (H). IOWA: Estherville, 1927, *Wolden* (Mich); Fayette Co., 1894, *Fink* (Mich, Mo, NY, US); Iowa Co., Amana, 1937, *Kiener* (Mo); Iowa Co., Homestead, 1939, *Kiener* (T, C). KENTUCKY: McCreary Co., Cumberland Falls, 1941, *McFarland* (Mo).

MAINE: Oldtown, 1897, *Ricker* (US); Trescott, 1923, *Norton* (F); Albion, 1922, *Parlin* (F); Oxford Co., Buckfield, 1930, *Parlin* (Y); Oxford Co., Canton, Peabody Ledge, 1934, *Parlin* (Y); Portage, 1907, *Riddle* (F); Warren, 1910, *Merrill* (F); Mt. Desert Island, Pemetic Mt., 1894, *no coll.* (D); Salisbury Cove, 1923, *Plitt* (DA); Oxford Co., Canton Point, 1942, 1945, *Parlin* (T); Androscoggin Co., Livermore, 1935, *Parlin* (T); Androscoggin Co., 1884, *Merrill* (F); Oxford Co., Buckfield, 1924, *Parlin*

(F); Litchfield, 1912, *Norton* (F). MARYLAND: Baltimore Co., 1911, *Plitt* (Mich); Baltimore Co., Ravine beyond the Caves, 1906, *Plitt* (DA); Baltimore Co., Lock Raven, 1905, *Plitt* (DA); Baltimore Co., The Caves, 1906, *Merrill* (F); Plummer's Island, Cabin John, Montgomery Co., 1907, *Fink* (Mich, US). MASSACHUSETTS: New Bedford, 1862-98, *Willey* (US, F); Waltham, *Mann* (US); Beverly, 1898, *Farlow* (F); Magnolia, 1903, *Farlow* (F); Blue Hills near Boston, 1892, *Barber* (F); New Bedford, *Clarke* (F); Duxbury, no other data (F); Wellesley, 1892, *Cummings* (Wel, Mich); Spot Pond, Medford, 1881 (Mo). MICHIGAN: Sailor's Encampment, 1899, *Harper* (C, F); Cheboygan Co., Reese's bog, shore of Burt Lake, 1941, *Phinney* (C); Keweenaw Co., Copper Harbor, 1947, *Thomson* (Wis); Bete Gris Bay, 1947, *Thomson* (Wis); Isle Royale, outlet of Siskowit Lake, 1930, *Lowe* (NY, Mich); Mud Lake Bog, Whitmore Lake, 1930, *Hedrick* (NY, DA, Mich); Saginaw, 1902, *Curtis* (Mich); Douglas Lake, west of Nigger Creek, 1931, *Miner* (Mich); Isle Royale, Rock Harbor, 1930, *Lowe* (DA, Mich); Miners Falls, Munising, 1933, *Lowe* (DA); Sugarloaf Mt., Marquette, 1933, *Lowe* (DA, Mich); Rock River, 1933, *Lowe* (DA, Mich); Lansing, *Beal* (F); Isle Royale, Tobin Harbor, 1930, *Lowe* (F, Mich); Marquette, 1933, *Lowe* (F); Isle Royale, McCargo Cove, 1930, *Lowe* (F); Isle Royale, Siskowit Lake, Ryan Island, 1930, *Lowe* (Mich). MINNESOTA: Grand Portage, Island, 1897, *Fink* (F, Minn); Bemidji, 1900, *Fink* (F, Mich, US, Minn); Roosevelt, 1901, *Fink* (DA); Old Hudson River Trading Post between Iron Mt. and Illusion Lakes, 1897, *Fink* (Mich); Tower, 1901, *Fink* (Mich, Minn); Warroad, 1901, *Fink* (Mich, Minn); Snowbank Lake, 1897, *Fink* (Mich, Minn, F); Minneapolis, 1896, *Fink* (Mich, Minn); Minneapolis Falls, 1899, *Gardner* (NY); Duluth, 1893, *Harper* (C); Kettle Falls, 1901, *Fink* (Minn); Henning, 1900, *Fink* (Minn); St. Louis River, 1886, *Arthur* (Minn); Gunflint, 1897, *Fink* (Minn); Misquah Hills, 1897, *Fink* (Minn); Beaver Bay, 1897, *Fink* (Minn); Koochiching, 1901, *Fink* (Minn); Tofte, 1897, *Fink* (Minn); Thief River Valley, 1900, *Fink* (Minn); Emo, 1901, *Fink* (Minn); Mankato, 1899, *Fink* (Minn); Oak Island, 1901, *Fink* (Minn); Beudette, 1901, *Fink* (Minn); Battle Lake, 1900, *Fink* (Minn); Granite Falls, 1899, *Fink* (Minn); Bearpaw Point, Itasca Park, Clearwater Co., 1946, *Evans* (Wis); Red Lake, 1900, *Fink* (Minn); Grand Marais, 1902, *Fink* (Minn). MISSOURI: St. Francis, 1929, *Mathias* (Mo); St. Genevieve Co., Terre Bleue Creek, 1898, *Trelease* (Mo); Neeleyville, 1892, *Dewart* (Mo); Turley, Rubidoux Creek, 1913, *Emig* (Mo). MONTANA: Glacier Nat'l. Park, 1941, *Mains* (F, Mich). NEW HAMPSHIRE: Shelburne, 1897, *Farlow* (DA); Shelburne, 1894, *Duggar* (Wis); White Mts., *Clarke* (F); Mt. Washington, 1934, *Thomson* (T); 1940, Mrs. *Hartmann* (T); The Flume, 1883, *Faxon* (F); 1936, *Logan* (T); Mt. Monadnock, 1883, *Swan* (F); Chocorua, 1904, *Farlow* (F); Belnap Co., Gilford, 1904, *Carter* (F); Twin Mt., 1895, *Harper* (C); White Mts., 1843, *Tuckerman* (F); North Woodstock, 1887, *Cummings* (Wel); Lisbon, 1894, *Stevens* (US). NEW JERSEY: no locality, *Austin* (F, NY); Wilmington Notch, 1896, *Britton* (F, Wel); Closter, *Austin* (NY); Wawayanda Swamp, Sussex Co., 1934, *Thomson* (T, Wis). NEW MEXICO: Santa Fe, 1926, *Arsene* (F); Colfax Co., Ute Park, 1916, *Standley* (F). NEW YORK: Essex Co., Chilson Lake, 1900, *Harris* (US, Wel); Penn Yan, *Buckley* (Mo); Lake George, Hulett's Landing, 1890, *Jelliffe* (P); Lake Placid region, Old Top near Minn. Lake, 1898, *britton* (NY); Essex Co., Wadham's Falls, 1886, *Burt* (F); Orient, Long Island, 1914, *Latham* (F); Buffalo, no other data (F); Trail to First Lake, Adirondacks, 1904, *Harris* (F); Ithaca, 1910, *Wolf* (DA); Blue Mt., 1922, *Cash* (DA); Cutchogue, 1919, *Latham* (DA); Adirondacks, Trail to Little Moose River, 1904, *Harris* (Mich); East Galway, 1893, *Burt* (Mich); Adirondacks, Panther Lake, 1904, *Harris* (Mich); Pantherkill Hollow, Catskill Mts., 1940, *Thomson* (T); Lake Placid region, Mirror Lake, 1893, *Britton* (F).

NORTH CAROLINA: Winklin, 1894, *Green* (Mich, F); Black Mts., 1868, *Russell* (Mich); Clingman's Dome, Swain Co., 1937, *Hubricht* (Mo, F); Nissen Park, 1922, *Schallert* (Mo, Wis); Tryon, 1928, *Evans* (F, Y); Yancey Co., Mt. Mitchell, 1913, *Standley & Bollman* (F, US); Buncombe Co., 1913, *Standley & Bollman* (F); Waynesville, 1910, *Standley* (F); Winston Salem, 1936, *Schallert* (Mo); Haywood Co., Sunburst, 1913, *House* (NY); Stokes Co., 1939, *Schallert* (H); Black Dome, 1877, *Dudley* (H); Whiteside Mt. near Highland, 1934, *Schallert* (H); Buncombe Co., Montreat, 1913, *Standley & Bollman* (US); Eagle's Nest near Waynesville, 1910, *Standley* (US).

OHIO: Clark Co., Springfield, 1876-77, *E.J.S.* (O); Fairfield Co., Amanda, 1892, *Kellerman* (O); Fairfield Co., 1934, *Wolfe* (Wolfe); Jackson Co., Rock Run, 1934, *Camp* (O); Champaign Co., Cedar Swamp, 1893, *Wilcox* (O); no locality, *Drege* (F); Columbus, 1892, *Bogue* (F); Orwell, 1892, *Bogue* (F); no locality, *Wilson* (NY). OKLAHOMA: Delaware Co., Dripping Springs, 1929, *Stratton* (Mich). OREGON: Eugene, 1933, *Sipe* (Mich); Waldport, *Sipe* (Mich); Corvallis, 1925, *Sipe* (Mich); no locality, 1871, *Hall* (F); Union Co., Mill Creek, 1897, *Sheldon* (NY, Wel, US); Rowena, Columbia River, 1933, *Lawrence* (Wel); Clatsop Co., Saddle Mts., 1936, *Browne* (H). PENNSYLVANIA: Haycock Mt., 1910, *Kaiser* (Mich); Center Co., 1869, *Rothrock* (C); Pike Co., Bushkill Falls, 1940, *Thomson* (T); Huntingdon Co., Penn. State College Nature Camp, 1937, 1939, *Thomson* (T). SOUTH CAROLINA: Santee Canal, 1846, *Ravenal* (F, US, Mo); Beaufort, 1868, *Mellichamp* (F). TENNESSEE: Elkmont, 1939, *Linder* (F): Smoky Mts. Nat'l. Park, Trail to Alum Cave, 1939, *Stevenson* (DA); Johnson City, 1904, *Moore* (NY, F). TEXAS: Houston, *Hall* (C). VERMONT: Lake Dunmore, 1896, *Farlow* (F, H); Windham Co., Wardsboro, 1935, *Moore* (Mo); Windham Co., Stratton, 1935, *Moore* (Mo); Mt. Hor, 1882, *Faxon* (F, Mich, Mo, Wis); Stowe, 1882, *Knight* (NY); Lake Dunmore, 1896, *Fley* (Mo); Sherburne, 1921, *Dutton* (Wis). VIRGINIA: Smyth Co., Nick's Creek, 1892, *Leeming* (NY); Smyth Co., near crest of Iron Mt., southeast of Chilhowie, 1941, *Strickland* (Mo); Sussex Co., Sussex, 1941, *Luttrell & Strickland* (Mo); Greensville Co., Emporia, 1941, *Allman & Luttrell* (Mo); Giles Co., trail to Barney's Well, near Mt. Lake, 1942, *Luttrell* (Mo); Isle of Wight Co., Chuckatuch, 1941, *Strickland & Luttrell* (Mo); James City Co., Diascund, 1941, *Luttrell* (Mo); Southampton Co., Selrell, 1941, *Luttrell & Strickland* (Mo); Bedford, 1919, *Harper* (C); White Top Summit, 1892, *Vail & Britton* (NY); Fauquier Co., High Point, 1937, 1938, *Allard* (US). WASHINGTON: Friday Harbor, San Juan Islands, 1912, *Zeller* (Mo); Westport, 1908, *Foster* (F); Queets River valley, Olympic Mts., 1907, *Frye* (F); Pierce Co., Edgewood, 1926, *Howard* (F); Langley, 1921, *Grant* (F, DA, Wis); Kalolock, 1939, *Smith* (F, C); Baker Lake, 1941, *Mains* (F, Mich); Cathlamet, 1907, *Foster* (F); Pacific Beach, 1911, *Foster* (F); Copalis, 1911, *Foster* (F); Clearwater River, 1939, *Smith* (Mich); Olympic Hot Springs, 1935, *Smith* (Mich); Olympic Mts., Elwha River, 1907, *Frye* (F, Wel); Mt. Baker, 1914, *Herre* (H); Whatcom Co., Mt. Baker, 1939, *Herre* (H); Port Angeles, 1914, *Foster* (Wel); Chehalis R., Montesano, 1898, *Heller* (NY, Mo, US); Seattle, 1907, *Frye* (F); Olympic Hot Springs, 1935, *Wilson* (F); Grays Harbor Co., Copalis Beach, 1948, *Everdam* (Wis). WEST VIRGINIA: no locality, Calkins (US); Pocahontas Co., Sitlington, 1925, *Gray* (F); no locality, 1893, *Nuttall* (C): Durbin, 1904, *Sheldon* (Mich). WISCONSIN: in addition to the specimens cited in the writer's paper (Trans. Wis. Acad. 38: 249-272. 1946 (1947)) on this state there should be added: Brown Co., vicinity of Green Bay, *Schuette* (C, NY). WYOMING: Yellowstone National Park, Yellowstone Falls, 1897, *Rydberg & Bessey* (NY); Laramie Peak, 1895, *Nelson* (Mo).

8b. PELTIGERA POLYDACTYLA var. TYPICA f. MICROPHYLLA

Anders, Lotus 76: 320, 1928

Peltigera perfida Gyel. apud Anders, Die Strauch und Laubflechten Mittel-europ. 49, 1928.—*Peltigera perfida* f. *lophyroides* Gyel., Magy. Bot. Lapok 28: 60, 1929.—*Peltigera microphylla* Gyel., Bryologist 34: 18 & 19, 1931.—*Peltigera microphylla* f. *lophyroides* A. Zahlbr., Cat. Lich. Univ. 8: 323, 1932.

This is merely the regeneration form of *P. polydactyla*, with tiny platelets which resemble isidia placed along the border of the thallus and along cracks and other injuries on the surface. It occurs sporadically through the range of the species.

Exsiccatae examined.—Thoms. 44; Tuck. 10 (NY).

Specimens examined.—ALASKA: Wrangell, 1905, *Engström* (Wel).

United States. NO STATE, Newport, 1839, *Russell* (P). CONNECTICUT: Newington, 1882, *Wright* (Y). KENTUCKY: Conway, 1922, *Fink* (DA). INDI-

ANA: Putnam Co., Fern, 1893, *Underwood* (NY); Decatur Co., Painters Creek, south of Greensburg, 1942, *Palmer & Daily* (C). MASSACHUSETTS: New Bedford, 1882, *Willey* (US, Minn). MICHIGAN: Rock River, 1933, *Lowe* (F). MINNESOTA: Trumbull Co., Cortland, 1899, *Fink* (Minn); Duluth, 1893, *Harper* (C). NEW JERSEY: no locality, *Austin* (NY). NEW YORK: Washington Co., Hudson Falls, 1913, 1914, *Burnham* (F). NORTH CAROLINA: Crowder's Mt., 1886, *Green* (Mo); Lynn, 1928, *Evans* (Y). OHIO: no locality, *Lesquereux* (F); Fairfield Co., 1934, *Wolfe* (NY). TENNESSEE: no locality, *Moore* (F). VIRGINIA: Greensville Co., Emporia, 1941, *Luttrell & Allard* (Mo). WASHINGTON: Sequim, 1916, *Grant* (NY). WISCONSIN: In addition to the specimen cited in the writer's paper (Trans. Wis. Acad. 38: 249-272. 1946 (1947)) on this state there should be noted the Exsiccatae specimen (Ranger Station, Brule, Douglas Co., 1946) and the following: Calumet Co., New Holstein, 1906, *Brenckle* (Mo).

8c. PELTIGERA POLYDACTYLA var. TYPICA f. LOPHYRA (Ach.) Nyl., Lich. Scand. 90, 1861, emend. Gyel., Magy. Bot. Lapok 29: 52, 1930

Peltidea horizontalis var. *lophyra* Ach., Lich. Univ. 516, 1810.—*Peltidea canina* var. *glabra* Ach., Synops. Lich. 239, 1814.—*Peltigera polydactyla* var. *dissecta* Müll. Arg., Flora 74: 374, 1891.

Gyelnik has placed these plants in the Acharius herbarium with the margins dilacerate to dilacerate crisped under the combination f. *lophyra*. He also used a f. *collina* Ach. but this refers to *Peltigera scutata* and f. *collina* should not be included in the synonymy of f. *lophyra*. This form is a sporadic variation of no particular significance.

Exsiccatae examined.—Cum. I. 17 (NY).

Specimens examined.—BRITISH COLUMBIA: Vancouver Island, Sidney, 1912, *Macoun* (F).

QUEBEC: Rimouski Co., Bic, 1940, *Lepage* (Mich); Rimouski Co., Ilet a Canuel, 1940, *Lepage* (Mich); Ste. Anne, 1935, *Lepage* (D).

United States. COLORADO: Custer Co., South Colony Creek, 1941, *Kiener* (C). CONNECTICUT: East Haddam, 1934, *Evans* (Y); Newington, 1882, *Wright* (F). ILLINOIS: Savanna, 1898, *Clinton* (C). IOWA: Fayette Co., 1894, *Fink* (Minn). MAINE: Oxford Co., Hartford, 1934, *Parlin* (Y). MASSACHUSETTS: New Bedford, 1884, *Willey* (US). MICHIGAN: Isle Royale, McCargo Cove, 1930, *Lowe* (Mich); Miners Falls, Munising, 1933, *Lowe* (Mich, F, NY). MINNESOTA: Mankato, 1899, *Fink* (Minn); New Ulm, 1899, *Fink* (Minn). NEW HAMPSHIRE: Mt. Deception, *Merrill* (F). NEW JERSEY: Closter, *Austin* (NY). NORTH CAROLINA: Chapel Hill, 1927, *Evans* (Y). WEST VIRGINIA: Renick, 1929, *Gray* (NY). WISCONSIN: specimen already cited in writer's paper (Trans. Wis. Acad. 38: 249-272. 1946 (1947)) on this state.

8d. PELTIGERA POLYDACTYLA var. TYPICA f. MICROCARPA (Ach.) Merat, Nouv. Flor. Lich. ed. 2, I: 199, 1821

Peltidea polydactyla var. *microcarpa* Ach., Lich. Univ. 529, 1810.—*Peltigera polydactyla* var. *hymenina* f. *microcarpa* Flot., 28 jahresber. Schleisch. vaterland. Kultur. 125, 1850.—*Peltigera polydactyla* var. *microcarpa* Krmphbr., Densk. d. k. Bayer. Bot. Ges. IV, abth. 2: 126, 1861.—*Peltigera polydactyla* f. *minor* Krmph., Reise Oester. Fregatt. Novara, Bot. theil Vol. I: 121, 1870.—*Peltigera polydactyla* var. *microcarpa* f. *cephalodigera* Müll. Arg., Flora 72: 144, 1889.—*Peltigera polydactyla* var. *nervosa* Gyel., Osterr. Bot. Zeit. 77: 225, 1928.—*Peltigera polydactyla* var. *subnervosa* Gyel., Magy. Bot. Lapok 28: 61, 1929.

This form is but an ecological dwarfed form of the typical plant with the

apothecia about 2 mm. or less across and the lobes less than 1 cm. across. The Gyelnik varieties *nervosa* and *subnervosa* represent insignificant variations of the venation of the undersurface and are not worth nomenclatorial recognition, complete gradation with the broader and more typical veins being found.

Exsiccatae examined.—Macoun 114 (US); Nyl. 32 (F); Roum. 34 (NY).

Specimens examined.—QUEBEC: Rimouski, St. Fabien, Nord du Pic Champlain, 1941, *Lepage* (H).

NOVA SCOTIA: Victoria Co., Baddeck, 1928, *Prince* (F).

United States. ARKANSAS: Hot Springs, 1898, *Trelease* (Mo). CALIFORNIA: Humboldt Bay, 1864, *Bolander* (F). DISTRICT OF COLUMBIA: *Lehnert* (Mich). IOWA: Fayette Co., 1895, *Fink* (NY); Iowa Co., Amana, Iowa River, 1937, *Kiener* (Mich). KENTUCKY: Conway, 1922, *Fink* (F). LOUISIANA: no locality, *Hale* (F). MAINE: Knox Co., within 10 miles of Penobscot Bay, 1904, *Merrill* (F). MASSACHUSETTS: Danvers, *Oakes* (F). MISSOURI: Perryville, 1886, *Demetrio* (Mo). NEW HAMPSHIRE: White Mts., 1843, *Tuckerman* (F). NEW JERSEY: Closter, *W.L.S.* (NY), OHIO: Columbus, 1892, *Bogue* (NY); Columbus, 1894, *Bogue* (F); no locality, 1836, *Biddlecombe* (F). OREGON: Yamhill Valley, McMinneville, *coll. illeg.* (F). VIRGINIA: Giles Co., Mt. Lake, 1941, *Luttrell* (Mo). WISCONSIN: in addition to the specimen listed in the writer's paper (Trans. Wis. Acad. 38: 249-272. 1946 (1947)) on this state the following should be added: Calumet Co., Wells (Brillion RR Sta.) 1944, *Benke* (C).

8e. PELTIGERA POLYDACTYLA var. CRASSOIDES Gyel. Magy.

Bot. Lapok 29: 51, 1930

Peltigera polydactyloides Nyl., Flora 46: 265, 1863.—*Peltigera Zahlbruckneri* Gyel., Bot. Koz. 24, 122, 1927.—*Peltigera polydactyla* var. *hymenina* Auct., non Ach. (vide Gyel. l. c.).—*Peltigera polydactyloides* var. *gunieensis* Gyel., Magy. Bot. Lapok 28: 61, 1929.—*Peltigera polydactyla* f. *dactylifera* Gyel., Annal. Mycol. 30: 453, 1932.

Usually the thallus is small and dark colored, thick, rigid instead of flexible; the diagnostic character being the confluence of the veins of the under surface to show almost no interspaces. The rhizinae are short and fasciculate as in var. *typica*. Other characters are as in the species. There is a close resemblance to *P. malacea* in the underside but the upper surface is smooth and shining instead of with the erect tomentum of that species.

Exsiccatae examined.—Bohl. 56 (NY); Mer. Tic. 89 (NY); Migula 212 (C, NY); 260 (C, F, NY); Roum. 314 (C); sub *P. canina* var. *spuria;* Schade 345 (Wel); Schaer. 1379 (NY).

Specimens examined.—ALASKA: St. Paul, 1897, *no coll.* (Mich); St. Paul Island, 1910, *Heath* (H); Kodiak Island, Kodiak, *Eyerdam* (F); Unalaska, 1899, *Setchell* (F).

ALBERTA: Banff, 1910, *Sanson* (F).

QUEBEC: Cap a l'Aigle, 1905, *Macoun* (F); St. Anne, Kamouraska, 1939, *Anselm* (Mich).

NEWFOUNDLAND: Bay of Islands, 1901, *Howe & Lang* (NY).

NOVA SCOTIA: Sable Island, 1913, *St. John* (F).

United States. COLORADO: Trail Ridge, Rocky Mt. Nat'l. Park, 1936, *Kiener* (Mich); St. Vrain District, Rocky Mt. Nat'l. Park, 1936, *Kiener* (Mich). CONNECTICUT: Woodbridge Ravine, Woodbridge, 1923, *Evans* (Y); Goshen, 1884, *Wright* (Y); Middletown, 1883, *Wright* (Y). FLORIDA: Monticello, 1890, *Lighthipe* (NY). ILLINOIS: Canton, *Wolf* (US). IOWA: Estherville, 1917, *Wolden* (DA); Decatur Co., Pleasantton, 1933, *Conard* (H). MASSACHUSETTS: South Bellerica, 1900, *Clinton* (Y). MINNESOTA: Tower, 1901, *Fink* (Minn). MISSOURI: Torrey Co., For-

sythe, 1897, *Trelease* (Mo). NEW JERSEY: Newton, Sussex Co., 1940, Thomson (T). NEW YORK: Orange Co., Chester, 1941, *Thomson* (T); Westkill Hollow, Catskill Mts., 1940, *Thomson* (T). OHIO: Urbana, 1876, *Bogue* (O). WISCONSIN: specimens have already been cited in the writer's paper (Trans. Wis. Acad. 38: 249-272. 1946 (1947) on this state.

8f. PELTIGERA POLYDACTYLA var. DOLICHORRHIZA Nyl., Synops. Lich. I, 327, 1860

Peltigera dolichorrhiza Nyl., Lich. Nov. Zeland. 43, 1888.—*Peltigera nana* Vainio, Philipp. Jour Sci., sect. C, vol. 8, 114, 1913.—*Peltigera oceanica* Gyel., Fedde Repert. 29: 9, 1931.—*Peltigera meridiana* Gyel., Magy. Bot. Lapok 26: 47, 1927.—*Peltigera dolichorrhiza* f. *javanica* Gyel., Nyt. Mag. f. Naturvid. 68: 269, 1930.—*Peltigera oceanica* f. *luzoni* Gyel., Fedde Repert. 29: 9, 1931.—*Peltigera canina* var. *dolichorrhiza* A. Zahlbr., Cat. Lich. Univ. III: 466, 1925 (lapsus calami).

This variety is similar to the species but has a generally thinner thallus and the rhizinae are simple, instead of usually fasciculate, and 5 mm or more long, dark brown to black. The underside is light brownish white to brown. Cotypes of *P. nana* in the herbarium of the New York Botanical Garden show this to be but a pusilloid form of the typical variety *dolichorrhiza* and the descriptions of Gyelnik's entities show no significant differences with this variety so that they have been reduced to the synonymy. Although this variety occurs throughout the range of the species, it is more common in tropical regions where it seems to be more likely to be collected than the var. *typica*.

Exsiccatae examined.—Funck I, 476 (NY): Macoun 89 (Wel); 90 (Wel, NY, Mo); 114 (Y); 133 (US); Merrill 3 sub *P. membranacea* (NY, Minn); 184 sub *P. canina* (NY); Spruce 57 sub *P. rufescens* (NY).

Specimens examined.—ALASKA: Port San Antonio, 1913, *Foster* (H); Port Echtes Lat. 60° 30′, 1892, *Macoun* (P); Farragut Bay, 1899, *Trelease* (Mo); Baranoff Island, Sitka, 1899, *Trelease* (Mo); Prince William Sound, Orca, 1936, *Norberg* (Mo); Cooks Inlet, Port Chatham, 1880, *Bean* (C); Sitka, 1865-66, *Bischoff* (US).

BRITISH AMERICA: no other locality, *Calkins* (C).

BRITISH COLUMBIA: Vancouver Island, Broughton Strait, 1899, *Trelease* (Mo); no locality, 1890, *Macoun* (P); Vancouver Island, Port Renfrew, *Schneider* (US, F), Skeena, 1892, *Macoun* (NY).

ONTARIO: Ottawa, 1892, *Macoun* (F); Ottawa, 1907, *Macoun* (F).

QUEBEC: Gaspé Co., 1882, *Macoun* (F).

NEWFOUNDLAND: Highlands of St. John, Deep Gulch, Doctor Hill, 1929, *Fernald, Long & Fogg* (F); Spruce Brook, 1928, *Spaulding* (F); St. Anthony, 1937, *Evans* (Y); Miquelon Island near Newfoundland, 1886, *Delamare* (US, Minn).

NEW BRUNSWICK: Campobello, 1902, *Farlow* (F).

NOVA SCOTIA: Near Pictou, 1901, *Howe & Lang* (NY); Colchester Co., Truro, 1924, *Prince* (F).

United States. CALIFORNIA: no locality, 1888, *Lemmon* (NY); Eureka, 1896, *Howe* (NY); Santa Cruz Mts., Hidden Villa Canyon, 1903, *Herre* (NY). CONNECTICUT: Norwich, 1885, *Setchell* (F); Granby, 1925, *McDonnell* (Y); Ledyard, 1937, *Evans* (Y); Granby, 1925, *Evans* (Y). KENTUCKY: McCreary Co., Cumberland Falls, 1941, *James* (Mich). MAINE: Oxford Co., Buckfield, 1930, *Parlin* (Mich, T, Y); Canton, Oxford Co., 1932, *Parlin* (Y); Oxford Co., Canton Point, 1945, *Parlin* (T); Baker Lake, head of St. John's River, 1917, *Nichols* (Y, F); Bear Hill, Rockport, *Merrill* (F); Chimney Pond, Mt. Katahdin, 1940, Ricker (US). MINNESOTA: Warroad, 1901, *Fink* (Minn); Emo, 1901, *Fink* (Minn). NEW HAMPSHIRE: King's Ravine, 1882, *no coll.* (F); Edmunds Trail, White Mts., 1927, *Sudbury* (Y); North

Woodstock (Cum. I, 17 at Y); Stickney Road, Bretton Woods, White Mts., 1927, *Sudbury* (Y); White Mts., 1874, *Willey* (US); Base of Mt. Washington, 1895, *Harper* (C); Cherry Mt., 1895, *Harper* (C); White Mts., between base station and Fabian's, 1917, *Taylor & R.E.C.* (DA). NEW MEXICO: Santa Fe Canyon, 1930, *Arsene* (F). NEW YORK: Essex Co., Pyramid Lake, 1906, *Harris* (F); Rifle Notch, 1900, *Britton* (NY); Westchester Co., Bedford, 1908, *Britton* (NY); vicinity of Lake Placid, Wilmington Notch, 1896, *Britton* (C, NY); Essex Co., Chilson Lake, 1899, *Harris* (NY). NORTH CAROLINA: Watauga Co., between Blowing Rock and Linville, 1933, *Leonard* (US); no locality, 1903, *Van Dyke* (F); Columbus, 1928, *Evans* (Y). OREGON: Benton Co., Beaver Creek, 1940, Doty (H, DA). PENNSYLVANIA: Brandy Creek, 1855, *Dr. Whs.* (C). VERMONT: Bristol Bog, 1927, *Dodge* (D); Bailey's Brook, Newfane, 1935, *Evans* (Y, 6 packets). WASHINGTON: Clearwater River, 1939, *Smith* (C, F); Kalalock, 1939, *Smith* (C, Mich, F); Sumner, 1906, *Harper* (C); Westport, 1908, *Foster* (F); Olympic Range, 1915, *Grant* (F); Whatcom Co., Mt. Baker, 1914, *Herre* (H); Loomis Lake, 1931, *Howard* (Wel). WEST VIRGINIA: no locality, *Calkins* (F); Cranesville, 1905, *Sheldon* (F). WISCONSIN: specimens have already been cited in the writer's paper (Trans. Wis. Acad. 38: 249-272. 1946 (1947)) on this state.

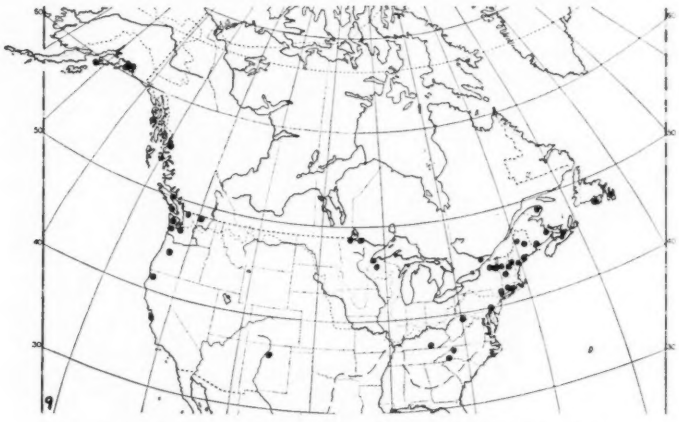

Fig. 9.—*Peltigera polydactyla* (Neck.) Hoffm. var. *dolichorrhiza* Nyl.

9. PELTIGERA MALACEA (Ach.) Funck

Crypt. Gewächse 33 heft, p. 5, 1827.—*Peltidea malacea* Ach., Synops. Lich. 240. 1814.—*Peltidea canina* var. *malacea* Wahlb., Flora Suec., vol. 2, 841, 1826.—*Peltigera canina* var. *malacea* Branthr. et Rostr., Bot. Tidssk. 3: 175, 1869.—*Peltigera malacea* var. *dactylodes* Gyel., Magy. Bot. Lapok 28: 60, 1929.

Thallus middle-sized, up to about 10 cm. in diameter, the lobes ascending, up to about 4 cm. long and 1-2 cm. broad. Upper surface brown to brownish-green or apple green, shining toward the center, with a sparse erect tomentum and sometimes also whitish pulverulent toward the apices of the lobes; the margins are inrolled and form a light border to the lobes. Under surface brownish at the margins, blackish brown to the center, lacking veins and covered with a fine even tomentum, sometimes with a few whitish interspaces; rhizinae sparse, black, fasciculate. Apothecia vertical, borne on extended lob-

ules, the sides reflexed, disk chestnut to blackish-brown; 4-8 mm. diameter, margin crenate; hypothecium pale to dark brown, hymenium pale brown to brown; paraphyses simple, thickened and darkened at the tip to a red-brown; asci cylindrico-clavate, 80 x 12 μ, 8 spored; spores acicular, 3-5 septate, 46-72 x 3.5-6 μ (Tuckerman reports 52-72 x 4-6; Fink reports 50-72 x 4-6).

Algal layer continuous, 35-50 μ thick; upper part of the cortex plectenchymatous, hyaline to pale brown, 25-50 μ thick, with trichomatic hyphae of 3-12 μ diameter and up to 150 μ long; medulla of exceedingly loosely interwoven hyphae, 10 μ in diameter with a lumen of 7 μ, medulla 450-1,800 μ thick; hymenium about 110 μ thick, hypothecium about 60 μ thick. Algae 4-8 μ in diameter.

Reactions: K minus, C minus, KC minus, P minus, I stains the asci blue, other parts being negative.

On soil.

Reported from Europe, Asia, Greenland, North Africa.

In North America largely Canadian, south to Colorado, Minnesota and New Hampshire.

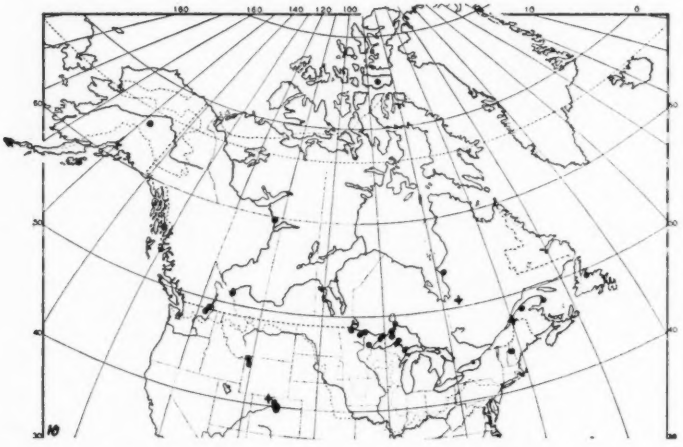

Fig. 10.—*Peltigera malacea* (Ach.) Funck. (solid dots—typical, plus signs—var. *polyphylla* Flot.)

Exsiccatae examined.—Abbayes 19 (Y); Anzi It. 89 (NY); Arn. Mon. 1468 (Minn, Mich); 74 (P); Funck 683 (NY, C); Macoun 176 (P); Malbr. 113 (F); Mig. 331 (NY, C, F); Moug. 1048 (NY); Rab. 763 (Mich, NY, C); R & S 116 (NY); Roum. 313 (C); Schaer. 700 (NY, F); Suza 73 (F); Wartm. 456 (Minn).

Specimens seen.—ALASKA: Behring Islands, 1891, *Macoun* (P); Unalaska, 1897, *Macoun* (F); Fairbanks, 1926, *Miller* (F); Kodiak Island, *Eyerdam* (Mich).

NORTHWEST TERRITORIES: Devon Island, Dundas Harbor, 1936, *Polunin* (F).

BRITISH COLUMBIA: Lillivet, 1916, *Macoun* (F).

ALBERTA: Fitzgerald, Slave River, 1917, *Brooks & Kindle* (F); Sulphur Mt., Banff, 1913, *Sanson* (F).

ONTARIO: Nipigon, 1912, *Jennings & Daily* (F, DA); Thunder Cape, northwest of Lake Superior, 1912, *Jennings & Daily* (DA).

QUEBEC: East Coast of Hudsons Bay, Fort Georges, 1944, *Lepage & Dutilly* (H); Bonaventure Island, Petite Cascapedia River, 1942, *Lepage* (H); Bic, Cap Caribou, 1907, *Collins & Fernald* (F).

NEWFOUNDLAND: Middle Arm, 1896, *Waghorne* (Mo, Minn, P).

United States. COLORADO: Long's Peak, 1938, *Kiener* (C); Long's Peak, 1937, *Kiener* (Mo, Wis); Larimer Co., Long's Peak, Glacier Basin, 1939, *Kiener* (NY); East Portal, 1929, *Plitt* (DA); Denver, 1921, *Plitt* (DA); Green Mt., near Boulder, 1921, *Plitt* (DA). MICHIGAN: Keweenaw Co., Copper Harbor, 1947, *Thomson* (Wis); Rock River, 1933, *Lowe* (DA, Wis, NY, F, Mich); Isle Royale, McCargo Cove, 1930, *Lowe* (Mich); Laughing Whitefish Point, Deerton, 1933, *Lowe* (Mich, DA, NY, C, F). MINNESOTA: Grand Marais, 1902, *Fink* (Mich, Minn); Blueberry Island, 1901, *Fink* (Minn, Mich); Kettle Falls, 1901, *Fink* (Mich, Minn); Warroad, 1901, *Fink* (Mich, Minn, D); Emo, 1901, *Fink* (Mich, Minn); Rainy Lake City, 1901, *Fink* (Minn); Roosevelt, 1901, *Fink* (US); Snowbank Lake, 1897, *Fink* (Minn); Island near northwest angle, 1894, *Sheldon* (Minn); Carlton Peak, 1902, *Fink* (NY). NEW HAMPSHIRE: White Mts., 1844, *Tuckerman* (US, F); Gate of Notch, 1882, *Faxon* (Mich, F); 1884, *Faxon* (Mo, Wis). WASHINGTON: Ferry Co., south of Laurier, 1931, *Howard* (F, Wel); Grosches Canyon, Republic, 1912, *Foster* (Wel). WYOMING: Yellowstone Park, 1872, *Hayden Expedition* (US, F); Gros Ventre Mts., 1900, *Curtis* (NY).

Several varieties and forms have been described but only var. *polyphylla* has been detected in North American material. Gyelnik has described a species, *P. avenosa,* which appears to be but a regeneration form of *P. malacea* and which I have therefore reduced to formal rank as 9b. *P malacea* f. *prolifera.*

9a. PELTIGERA MALACEA var. POLYPHYLLA Flot. apud Sturm, Deutsch. Flora II, abth., Heft 28-29, p. 47, 1835

Peltigera malacea f. *polyphylla* Körb., Syst. Lich. Germ. 57, 1855.

In this variety the lobes are small, thickly set together, more or less erect and crisped. It seems to be an Alpine and arctic modification of this species.

Reported from Europe. New to North America.

Exsiccatae examined.—Gyel. 33 (F).

Specimens seen.—QUEBEC: Ste. Anne, Kamouraska, 1939, *Anselm* (Mo); Pine Barren, Rupert River and Mistassini Lake, Martin River, 1943, *Dutilly & Lepage* (H).

United States. COLORADO: Larimer Co., Rocky Mt. Nat'l. Park, 1938, *Kiener* (F).

9b. **Peltigera malacea** f. **prolifera** Thomson n. f.

Peltigera avenosa Gyel., Bryologist 34: 18, 1931 (nomen nudum) et Annal. Crypt. Exot. 4: 168, 1932.

Thallus ad marginem et ad rimas isidiatus, ceterum ut in species.

This form is based on the species of Gyelnik which he reports from the United States on the basis of a specimen in the herbarium of the University of Uppsala, Sweden, labeled Oregon Boundary Commission, 1858-1859 and collected by Lyall. I have seen no specimens myself that I could place in this regeneration form.

10. PELTIGERA LEPIDOPHORA (Nyl.) Vainio

Meddel. Soc. Fauna et Flora Fennica 6: 130, 1881.—*Peltigera canina* var. *lepidophora* Nyl. apud Vainio, Meddel. Soc. Fauna et Flora Fennica 2: 49, 1878.

Thallus small, of small lobes up to 2 cm. across, the edges ascending, sometimes making the lobes cochleate. Upper surface tomentose and with peltate isidia containing the same alga as the thallus scattered over the surface; brown to grayish-blue. Under surface pale to brown with iregular raised venation; rhizinae simple to fibrillose, pale to brown. Apothecia small, 1.5-4.5 mm. across, on extended lobules, the margin crenate; disk brown; hypothecium color not mentioned; hymenium hyaline to pale brown; paraphyses thickened and red-brown at the tips; asci sparse; spores acicular, 55-85 x 4-4.5 μ.

Algal layer continuous, 40-75 μ thick; upper parts of the cortex plectenchymatous, hyaline to pale brown, 40-50 μ thick; medulla of loosely interwoven hyphae of 5 μ diameter with a lumen of 4 μ; medulla 75-150 μ thick. Algae 3-6 μ in diameter.

Reactions: K minus, C minus, KC minus, P minus, I minus; I did not have fruiting material available to test the hymenial reaction.

On soil among mosses.

Reported from Europe and Greenland. Rare in North America.

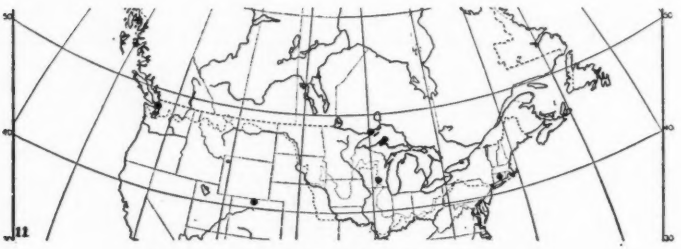

Fig. 11.—*Peltigera lepidophora* (Nyl.) Vainio

Exsiccatae examined.—Arn. 1469 (Mich, Minn); Krypt. Vind. 2055 (NY); Savicz 20 (T); Thoms. 71.

Specimens examined.—ONTARIO: High falls of Pigeon River, 1948, *Thomson* (Wis).

United States. CONNECTICUT: Middlesex Co., East Hampton, 1927, *Evans* (F, Y). COLORADO: Larimer Co., on ground among mosses, east slope of Long's Peak, 11,300 ft. alt., 1938, *Kiener* (C). MICHIGAN: Keweenaw Co., collected at Copper Harbor, Mt. Bohemia and Cliff Mine, 1947, *Thomson* (Wis). WISCONSIN: Columbia Co., on sandstone ledge, 3 miles northwest of Lodi, 1945, *Thomson* (Exsic. no. 71). WASHINGTON: Puget Sound Islands, Olga, Orcas Island, 1906, *Fink* (Wel).

As is mentioned in the discussion of *P. canina,* some peculiar specimens of this species have been collected. The original description of Nylander agrees for the most part with the Colorado, Washington and Wisconsin specimens:

"Thallus minutus (Longitudine et latitudine circ. semipollicaris, raro longit. fere 1-pollicaris), rotundatus, vel rotundato-lobatus, opacus, fuscescens, luridus vel lividus, sat

tenuis, membranaceus, saepe concavus (margine constricto), squamulis minutis super laminam sparsis munitus, subtus albidus, obscurus vel fuscescens, nervis rhizinisque concoloribus vel obscurioribus; apothecia non visa—."

The difficulty with the specimens from Colorado, Washington and Wisconsin is that some of the lobes are not only isidiate with the peltate isidia characteristic of *P. lepidophora* but are also sorediate. Except for the isidia, they resemble typical material of what most modern authors call *P. erumpens* or what I have here treated as *P. canina* var. *spuria* f. *sorediata*. They are sterile, like most material of *P. lepidophora*. Fruiting plants have been reported only from Esthonia by Linkola (Mem. Soc. Fauna Flora Fennica 7, 1932) and from Finnland by Ahlner (Mem. Soc. Fauna Flora Fennica 12: 54, 1936). The photograph in Ahlner's paper shows plants which are quite similar to the spuria type of thallus but with the prominent isidia showing clearly. The fruit characters in my description are based on Ahlner's account.

11. PELTIGERA CANINA (L.) Willd.

Flora Berolinens. Prodrom. 347, 1787.—*Lichen caninus* L., Sp. Pl. 1149, 1753.—*Lichen caninus* var. *cinereus* Weis., Flor. Goetting. 78, 1770.—*Lichen terrestris* Lam. Flore Franc., I, 84, 1788.—*Lichen venosus* Gilib., Exercit. Phytol. 601, 1792 (non Linn.).—*Peltidea canina* Ach., Method. Lich. 283, 1803.—*Dermatodea canina* St. Hil., Expos. Famil. Natur. 20, 1805.—*Peltigera canina* var. *palmata* Del. apud Duby, Bot. Gallic. II: 598, 1830.—*Peltigera canina* var. *vulgaris* Duby, Bot. Gallic. II, 598, 1830.—*Peltigera canina* f. *digitata* Hazsl., Birod. Zuzmo-Flor. 56, 1884.—*Peltigera canina* var. *membranacea* f. *palmata* Oliv., Expos. Lich. Ouest. France I, 156, 1897.—*Peltigera canina* var. *canina* Boist., Nouv. Flore. Lich. 2, 80, 1903.—*Peltigera plittii* var. *macrolobata* Gyel., Fedde Repert. 29: 9, 1931.—*Peltigera plittii* var. *sandwicensis* Gyel., Fedde Repert. 29: 9, 1931.—*Peltigera plittii* f. *suffusa* Gyel., Lilloa 3: 64, 1938.—*Peltigera canina* f. *palmata* A. Zahlbr., Cat. Lich. Univ. III, 464, 1925.

Thallus very variable; size up to 30 cm. or more across; lobes up to 8 cm. across. Upper surface slate gray, greenish-brown, or brown above with an arachnoid or dense tomentum toward the margins, the center dull or shining; in one form with coarse gray soredia in rounded spots on the upper surface; another form with the flat platelets or isidia of regeneration following injury. Under surface with a strong network of raised white to brown veins, with white to brown, simple, fasciculate, or fibrillose rhizinae which sometimes form a confluent spongy mat below. Apothecia vertical on extended lobules 6-10 mm. across, the sides usually reflexed, the disk light brown to reddish-brown or chestnut brown or black, the margin crenate; hypothecium brown, hymenium hyaline to brown; paraphyses thickened and red-brown at the tips, asci cylindrico-clavate 90 x 10 μ, 8 spored; spores acicular, hyaline to yellowish, 23-67 x 3-6.5 μ (Tuckerman reports 44-70 x 3-6, Fink reports 38-72 x 3-5).

Algal layer continuous, 40-80 μ thick; upper part of the cortex plectenchymatous, hyaline to pale brown, 40-70 μ thick, with trichomatic hyphae; medulla of rather compact hyphae, more or less arranged parallel to the surfaces, 5-8 μ in diameter with a lumen of 3-5 μ, medulla 300-500 μ thick; hymenium 70-110 μ thick; hypothecium 35-60 μ thick. Algae 4-8 μ in diameter.

Reactions: K minus, C minus, KC minus, P minus, I stains the asci blue, other parts are negative.

On soil, rocks, rotten logs, bases of trees.

A cosmopolitan species, ranging over all North America.

None of the other species of Peltigera give as much trouble in determinations as *P. canina*. Its variability is so great and the stages of growth through which it may pass are so different in appearance that most authors have described a large number of species. Some, such as Scholander and Ericksen, have expressed doubts with respect to some of the species. This has already been called to attention in a previous paper by the writer (Trans. Wis. Acad. Sci. 38: 249-272, 1947). One of the most germane observations has seemingly escaped the attention of lichenists who have split *P. canina* into many species. H. Lange in writing "Zur Flechtenflora des Erzgeberges" (Hedwigia 69: 56-83, 1930) comments upon observations made over a period of years on several colonies of what he called *P. spuria*. I take the liberty of translating his comments:

"*P. spuria* (Ach.) D.C. Infrequent in the region, but very evanescent. At different times the development of several colonies was observed over a period of several years. At first there appeared only single, more or less isolated, strongly hollowed, thalli as large as a pea. In the second year the thalli are somewhat larger, especially in the long axis; several already bear the fruit primordia. The one and two year old thalli frequently bear the rounded, sorediose, "soreumatischen," spots (— var. *erumpens*), which will be retained by many individuals. In the third year the fruiting is at its height. In the fourth year there is no longer a trace (of the plant) to be found, for example at the amphibole rock dyke south of Crottendorf where I had previously found it covering many square meters. Similar cases were observed by me at a place in the roadside ditch south of Marmorbruche and at a roadside near Annaberg by Röhling. At many places relics were observable for several years longer. In one large turf in a bog between Hermannsdorf and Elterlein a "lepidophora" form appeared between fruiting thalli. In unfavorable places the young sorediate forms persist and finally die without producing apothecia (such as on the woods road of southern Cranzal)."

My own observation upon the sorediate plants growing along the roadside ditches and rock outcrops of northern Wisconsin but confirm Lange's statements that the sorediate plants are juveniles of the *spuria* type of thallus.[1] Field observations also lead me to state that the *spuria* intergrades with the *rufescens* types of thalli to such an extent that they cannot be maintained as separate species. And further, as previous authors have stated, typical *rufescens* and typical *canina*, or what I have called var. *albescens* in a previous paper, are easily separable. But when one observes these plants in the field or in a very large series of herbarium specimens, the number of intermediate specimens becomes so numerous and so obvious that recognition of these as separate species becomes untenable. If one wishes to give these ecological and growth stage variants some nomenclatorial recognition, it becomes necessary to use the cumbersome trinomial and quadrinomial system that I have followed here and in a previous paper.

The "lepidophora" form which Lange mentions is most interesting. I had been much puzzled by a large colony along a sandy roadside ledge in southern Wisconsin (specimens distributed as Lich. Wis. Exs. 71) which had all the

[1] While the above was in page proof Eilif Dahl's paper on Greenland lichens (Medd. om Gron. 150, No. 2: 1-176. 1950) was received. On page 22 is a discussion of the *P. spuria* problem including observations proving the sorediate plants are only a stage of development.

appearance of the *P. erumpens* type of thallus. The lobes were small, cochleate, tomentose above and many with the characteristic soralia on the upperside. However, all of the thalli showed the peltate isidia diagnostic of *P. lepidophora*. Dr. Kiener first reported the occurrence of *P. lepidophora* in North America (Bryologist 42: 142-149, 1939). The determinations were made for him by Gyelnik. One of these specimens from Colorado (Kiener 6753) in the herbarium of the Chicago Museum of Natural History is of the same type as the collection which I made in Wisconsin. The lobes are cochleate, small and look like "*P. erumpens*" but bear peltate isidia. Those lobes which are both sorediate and isidiate raise serious doubt as to the specific validity of *P. lepidophora* if the soredia are accepted as the important diagnostic character. In such a case these specimens would be placed as "*P. erumpens*." However, the presence of soredia here, as well as in cases of *P. canina* leads me to consider the peltate isidia as the important character and the soredia as merely accessory. As cited under *P. lepidophora* a collection made in Connecticut by A. W. Evans resembles more closely the European specimens than the peculiar specimens from Colorado and Wisconsin. The lobes are broader and lack the soredia which the latter specimens exhibit. A specimen in the Wellesley herbarium collected by Bruce Fink in Washington is similar to the Wisconsin and Colorado specimens.

The series of species which Gyelnik has described in the *canina group* such as *P. suomensis*, *P. Plittii* and forms, and *P. coloradoënsis* seem quite unacceptable. A co-type of *P. coloradoënsis* is in the Dept. of Agriculture herbarium and co-types of *P. Plittii* f. *ornata* are in the Yale herbarium and my own herbarium. A co-type of *P. Plittii* f. *subsuffusa* is in the Yale Herbarium as well as authentic determinations of *P. suomensis* by Gyelnik. All of these can be placed without hesitation as *P. canina* var. *rufescens*. The characters of tomentum and abundance of rhizinae upon which they are based are very unreliable with no clear-cut separation, so that I find no alternative but to reduce them to synonymy. Although I have not seen authentic material of *P. mexicana* Gyel. I strongly suspect that it will fall in the same category.

A key to the varieties and forms of *P. canina* is given below but for one reason or another a few specimens could not be assigned to one of these categories. Some of the more interesting intermediates are cited below:

Mig. 69 sub *P. horizontalis* (NY)—has the shining surface and penicillate rhizinae of *P. membranacea* but also simple rhizinae of var. *ulorrhiza* and the dark veins. Washington, Langley, 1924, Grant (C—no. 975234)—has the veins of *P. membranacea* but is dull above, has the texture and shape of var. *rufescens* and the rhizinae of var. *spongiosa*. Howe 40 (F)—could be put equally well in vars. *spongiosa*, *rufescens* or *ulorrhiza*. Vermont, Middlebury, 1897, Burt (F)—is intermediate between vars. *albescens* and *ulorrhiza*.

KEY TO THE VARIETIES AND FORMS OF P. CANINA

1. Thallus large, lobes usually longer than 3 cm. prostrate with only the margins ascending; rhizinae simple or fibrillose.
   2. Rhizinae simple or fibrillose but not confluent or forming a spongy mat below.
      3. Veins white, rhizinae white; plant usually of shady places and bogs, pliable; grayish or brownish-green in color .....11a. *P. canina* var. *albescens*.
      3. Veins brown, often white at the margins, rhizinae brown.

4. Lacking isidia.
5. Lobes long and broad, over 1.5 cm. across, veins brown to margin, plant pliable, growing in shady places; tomentum of upperside usually arachnoid .....11b. *P. canina* var. *ulorrhiza*.
5. Lobes short and narrow, usually less than 1.5 cm. across, veins usually white near the margin, brown to the center; plant brittle, often splitting when pressed; growing in sunny places; tomentum of upper surface usually fairly dense .....11c. *P. canina* var. *rufescens*.
4. With small, squamulose isidia along the edge of the thallus or on the upper surface, especially along cracks .....11d. *P. canina* var. *rufescens* f. *innovans*.
2. Rhizinae fibrillose-confluent .....11e. *P. canina* var. *spongiosa*.
1. Thallus small, lobes up to 3 cm. long, ascending, often cochleate; veins raised, narrow, white at the margins, brown to the center; rhizinae simple to pappose (sometimes fibrillose in f. *sorediata*).
6. Thallus lacking soredia .....11f. *P. canina* var. *spuria*.
6. Thallus with coarse gray soredia in rounded spots on the upper surface .....11g. *P. canina* var. *spuria* f. *sorediata*.

11a. PELTIGERA CANINA var. ALBESCENS (Wahlb.) Thoms., Trans. Wis. Acad. 38: 262, 1947

Peltidea leucorrhiza Flk., Deutsch. Lich. No. 153, 8 Lief. 10, 1821.—*Peltidea canina* var. *albescens* Wahlb., Flora Suec. II, 842, 1826.—*Peltigera canina* var. *leucorrhiza* Flot., 28 Jahresber. Schlesisch. Gesellsch. für vaterland. Kultur. 124, 1850.—*Peltigera canina* var. *membranacea* f. *genuina* Krmphbr., Denkschrift. Kgl. Bayer. Bot. Gesell. 4, 2 abth. 124, 1861.—*Peltigera canina* f. *leucorrhiza* Arn., Flora 67: 233, 1884.—*Peltigera canina* var. *membranacea* f. *leucorrhiza* Oliv., Expos. Lich. Ouest. France I, 156, 1897.—*Peltigera canina* var. *membranacea* f. *palmata* Oliv., loc. cit. p. 156.

This variety would correspond to var. *typica* but because there is already a varietal designation this has been adopted. Typical material of *P. canina* is thus rather uncommon in North America; most of our collections belong to var. *rufescens*. Gyelnik (Bot. Koz. 24: 122-140, 1927) gives most of the characters that I have used in distinguishing vars. *albescens* and *rufescens* and in addition states that the vertical cell walls of the cortex are 1-2 μ thick in *canina* (*albescens*) and 2-3 μ thick in *rufescens* but I have not been able to substantiate this. All of the varieties of *P. canina* intergrade so much that it is often difficult to place a particular specimen. This is particularly true of vars. *albescens*, *ulorrhiza* and *rufescens*.

Exsiccatae examined.—Cum II, 38 (C); Flag. Fr.-C. 9 (F); Krypt. Vind. 1547 (Wel, F); Macoun 91 (Mo); Malme 483 (F, Wis); 881 (F); Mig. 329 (NY, C, F); Mudd 59 (F); R & S. 114 (NY); Schaer 893 sub *P. canina* var. *membranacea* (NY).

Specimens examined.—ALASKA: Thum Bay, 1940, *Eyerdam* (F); Kodiak Island, 1899, *Trelease* (Mo); Yakutat Bay, Disenchantment Bay, 1899, *Trelease* (Mo).

NORTHWEST TERRITORIES: British America, 1868, *Kellogg* (F).

BRITISH COLUMBIA: Vancouver Island, 1858-59, *Lyall* (F).

ALBERTA: Banff, 1910, *Sanson* (F).

ONTARIO: Cochrane, *Locher* (Mich); Pine Lake, Muskoka Lakes, Gravenhurst, *Locher* (Mich).

QUEBEC: Montreal, 1851, *Watt* (Mo) Bic Co., Rimouski, 1939, *Lepage* (Mich); Roberval near Ouiachouan Falls, 1894, *Barnhart* (NY).

NEWFOUNDLAND: Valley of Exploits River, Grand Falls, 1911, *Fernald & Wiegand* (Wel, D, F).

NOVA SCOTIA: Victoria Co., Big Harbor, 1928, *Prince* (F); Yarmouth, 1910, *Macoun* (F); Colchester Co., Upper Brookside, East Mt., 1928, *Prince* (Wis).

United States. ARIZONA: Chiricahua Mts., Monument Peak, 1906, *Blumer* (C). COLORADO: Headwaters of Clear Creek and ridges east of Middle Park, 1861, *Parry*

(F); Routt Co., Steamboat Springs, 1903, *Goodding* (NY, US); Pagosa Peak, 1899, *Baker* (Mo). IDAHO: Forest between Priest Lake and East Fork, 1900, *MacDougal* (NY); Priest River, 1914, 1915, *Weir* (F); near Elk Creek Falls, 1900, *Abrams* (H); Shoshone Co., Elk Creek Falls, 1900, *Abrams* (H); Moscow, 1935, *Herre* (H). KENTUCKY: Bath Co., Olympia, 1941, *James* (NY). MAINE: Trescott, Grand Falls, 1911, *Fernald & Wiegand* (F); Washington Co., 1929, *Markin* (Wis). MICHIGAN: Keweenaw Co., Agate Harbor, 1947, *Thomson* (Wis); Macinac & Chippewa Cos., Prentis Bay, 1923, *Nichols* (Y, Mich); Alger Co., Chatham, 1900, *Wheeler* (Mich, F); Emmett & Cheboygan Cos., Burt & Douglas Lakes, 1922, *Nichols* (F). MINNESOTA: Collegeville, 1910, *Hansen* (F); Oak Island, Lake of the Woods, 1901, *Fink* (Mich); Mainland, 1901, *Fink* (Mich, US); Cook Co., Hungry Jack Lake, *Wilson* (Wis); no locality, 1889, *Wood* (US); Henning, 1900, *Fink* (Minn). MONTANA: Glacier

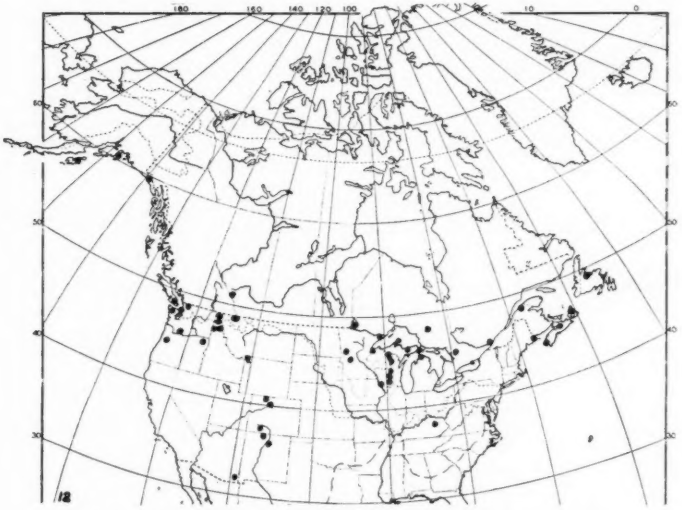

Fig. 12.—*Peltigera canina* (L.) Willd. var. *albescens* (Wahlb.) Throms.

Nat'l. Park, 1941, *Mains* (F, Mich). NEW MEXICO: Rio Arriba Co., Brazos Canyon, 1914, *Standley & Bollman* (US); Santa Fe, 1930, *Arsene* (F). NORTH CAROLINA: Moore's Springs, 1930, *Schallert* (Wis). OREGON: Corvallis, 1917, *Anderson & Gilbert* (F); Wallowa Co., by cascade left fork of Wallowa River, 1897, *Sheldon* (US). WASHINGTON: Olympic Hot Springs, 1935, *Smith* (Mich); Baker Lake, 1941, *Mains* (Mich); Friday Harbor, 1918, *Herre* (H); Klickitat Co., Husum, 1926, *Jones* (Wel). WISCONSIN: specimens have already been cited in the writer's paper (Trans. Wis. Acad.) 38: 249-272. 1946 (1947)) on this state. WYOMING: Cummings, 1895, *Nelson* (F); Yellowstone Nat'l. Park, Druid Peak, 1899, *Nelson* (US); Yellowstone Nat'l. Park, 1922, *Hawkins* (Wis).

11b. PELTIGERA CANINA var. ULORRHIZA (Flk.) Schaer. Enum. Critic. Lich. Europ. 20, 1850

Peltidea ulorrhiza Flk., Deutsch. Lich. no. 154, 11, 1821.—*Peltigera canina* var. *coriacea* f. *campestris* Krmplhbr., Denkschrift. Kgl. Bayer. Bot. Gesellsch. 4, 2 abth., 125, 1861.—*Peltigera canina* f. *ulorrhiza* Oliv., Memoir. Soc. Nation. Sci. Natur. Cherbourg 36: 218, 1907.

This variety is an intermediate between the larger, light undersurfaced var. *albescens* and the smaller, usually dark undersurfaced var. *rufescens*. In this variety the veins and rhizoids are dark brown, the veins to the margin; the interspaces are creamy to pale brown.

Exsiccatae examined.—Anzi It. 91 (NY); Flag. 157 (F); Howe 40 (F); Krypt. Vind. 1547 (NY); Mig. 69 sub *P. horizontalis* (Mich); Rab. 560 (Mich, Wis); Schaer. 1103 (NY—but is var. *rufescens* in same no. in herb. F); Wagn. 19 (NY).

Specimens examined.—ALASKA: Aqua Dulce River, Yakutat Bay, 1899, *Trelease* (Mo).

BRITISH COLUMBIA: New Westminster, 1902, *Hill* (F); 1903, *no coll.* (F).

ALBERTA: Banff, 1913, *Sanson* (F).

NEWFOUNDLAND: Valley of Exploits River, Grand Falls, 1911, *Fernald & Wiegand* (Wel).

NOVA SCOTIA: Colchester Co., East Mt., Upper Brookside, 1928, *Prince* (Mich); 1924 (Mich).

United States. CALIFORNIA: Santa Cruz Mts., 1903, *Herre* (Mich); Santa Cruz Mts., 1885, *Farlow* (F); no locality, *Bolander* (F); Adobe Canyon, Sonoma Co., 1894, *Bioletti* (NY); San Mateo Co., Bear Gulch Road near Woodside, 1904, *Herre* (H); Placer Co., Gold Run, 1935, *Copeland* (D). COLORADO: Pagosa Peak, 1899, *Baker* (F, US); Rocky Mt. Nat'l. Park, South St. Vrain Canyon, 1937, *Kiener* (Mo); Middle Park, Clear Creek, 1861, *Parry* (Mo); Twin Lakes, 1873, *Wolf* (F, NY); Larimer Co., Tributaries of south Fork of Cache La Poudre River, 1896, *Pammel* (Mich); Rocky Mt. Nat'l Park, Long Lake, 1934, *Kiener* (Mich). CONNECTICUT: Branford, 1924, *Nichols* (F); Wethersfield, 1882, *Wright* (F); Canton, 1933, *Evans* (Y); Wintergreen Falls, Hamden, 1866, *Eaton* (Y); Killingworth, 1874, *Hall* (Y); Glastonbury, *Starmer* (Y); New Haven, 1873, *Eaton* (Y); north slope of Pine Rock, New Haven, 1874, *Eaton* (Y).

IDAHO: Latah Co., Cedar Creek, 1897, *Henderson* (Wel). MAINE: Franklin Co., Greenvale, 1894, *Furbish* (F); Mt. Megunticook, *Camden* (F); Oxford Co., Buckfield, 1924, *Parlin* (F); Lake Wood, 1928, *Plitt* (DA); Cumberland, 1857, *Blake* (US). MARYLAND: Baltimore Co., along the Gunpowder River, 1910, *Plitt* (DA). MASSACHUSETTS: Waltham, 1893, Burt (F); Schutesbury, 1874, *Tuckerman* (F); Lunenburg, 1883, *Sargent* (F). MICHIGAN: Keweenaw Co., Fort Wilkins, 1947, *Thomson* (Wis); Sagatuck, 1935, *Darrow* (Mich, F, Mo); Prentis Bay, 1923, *Nichols* (Y); Isle Royale, Tobin Harbor, 1930, *Lowe* (Mich). MINNESOTA: Redwood Falls, 1899, *Fink* (Mich); Winona, 1889, *Holzinger* (NY). MISSOURI: Greene Co., Turner, 1911, *Standley* (US). NEW HAMPSHIRE: Tamworth, 1906, *Bartlett* (Mich); North Woodstock, 1892, *Cummings* (F); Chocorua, 1910, *Farlow* (DA); Middle Mt., North Conway, 1854, *Putnam* (C); North Sandwich, 1935, *Moore* (Mo). NEW JERSEY: Closter, *Austin* (NY). NEW MEXICO: no locality, 1848, *Fendler* (F). NEW YORK: Essex Co., Wadham's Falls, 1886, *Burt* (F); Fort Ann, 1913, *Burnham* (F); Clyde, 1886, *O.F.C.* (NY); Onoville, 1926, *Alexander & House* (DA); Ithaca, 1884, *Dudley* (H). NORTH CAROLINA: Chapel Hill, 1937, *Evans* (Y). OHIO: no locality, *Lea* (P).

OREGON: no locality, 1871, Hall (F). PENNSYLVANIA: Huntingdon Co., Penn State College Nature Camp, 1937, *Thomson* (Wis). VERMONT: Leicester, 1920, *Dutton* (Wis, F); Brandon, 1920, *Dutton* (F); 1922 (Mich); 1911 (Mo); Newfane, 1893, *Howe* (NY); Pawlet, 1913, *Dodge* (D); Sudbury, 1913, *Dodge* (D). VIRGINIA: Madison Co., White Oak Canyon, Shenandoah Nat'l. Park, 1942, *Luttrell* (Mo); Smyth Co., Waker Mt., 1892, *Leeming* (NY). UTAH: Gold Basin, La Sal Mts., 1911, *Rydberg & Garrett* (NY); Horse Gulch, La Sal Mts., 1911, *Rydberg & Garrett* (NY). WASHINGTON: Mt. Rainier, 1906, *Foster* (F). WEST VIRGINIA: Mannings Ferry, 1894, *Harper* (C); Pocahontas Co., Cass, 1927, *Gray* (Mich); Pocahontas Co., Spruce, 1927, *Gray* (Mich). WISCONSIN: in addition to those specimens cited in the writer's paper (Trans. Wis. Acad. 38: 249-272, 1946 (1947)) on this

state there should be added: Dane Co., Albion, 1868, *Greene* (F). WYOMING: Medicine Bow Nat'l. Forest near Brookline Lake, 1922, *Wehmeyer* (DA); Yellowstone Falls, Yellowstone Nat'l. Park, 1897, *Rydberg & Bessey* (NY).

11c. PELTIGERA CANINA var. RUFESCENS (Weis.) Mudd, Manual of Brit. Lich. 82, 1861

Lichen caninus var. *rufescens* Weis., Plant. Cryptog. Flor. Goettingens. 79, 1770.—*Lichen rufescens* Neck., Method. Muscor. 79, 1771.—*Peltigera canina* var. *Lichen rufescens* Willd., Flora Berolinens. Prodrom. 248, 1787.—*Lichen rufus* Gmelin., System Natur. II, Pars II, 1373, 1791.—*Peltigera rufescens* Humb., Flor. Friburg. Specim. 2, 1793.—*Peltidea rufescens* Ach., Method. Lich. 285, 1803.—*Peltidea canina* var. *crispa* Ach., Lich. Univ. 519, 1810.—*Peltidea canina* var. *inflexa* Ach., Lich. Univ. 518, 1810.—*Peltidea malacea f. inflexa* Ach., Synops. Lich. 240, 1814.—*Peltidea canina* var. *rufescens* Hook., Flora Scotia II, 60, 1821.—*Peltigera canina* var. *crispa* Merat, Nouv. Flor. Envir. Paris ed. 2, I, 199, 1821.—*Peltigera canina* var. *inflexa* Duby, Bot. Gallic. II, 598, 1830.—*Peltigera canina* f. *ulophylla* Wallr., Flora Crypt. Germ. III, 559, 1831.—*Peltigera canina* var. *crispata* Kickx., Flora Cryptog. Louvain. 91, 1835.—*Peltigera rufescens* var. *crispa* Kicks., loc. cit. 91, 1835.—*Peltigera malacea* var. *ulophylla* Flot., apud Sturm. Deutschl. Flora II abth. Heft 28-29: 47, 1835.—*Peltigera rufescens* var. *pachphylla* f. *crispa* Flot., 28 Jahresber. Schlesisch. Gesellsch. Vaterländ. Kultur 124, 1850.—*Peltigera rufescens* f. *incusa* Körb., Syst. Lich. Germ. 59, 1855.—*Peltigera canina* var. *coriacea* f. *genuina* Krmplhbr., Denk. Kgl. Bayer. Bot. Gesellsch. 4, 2 abth. 124, 1861.—*Peltigera canina* var. *coriacea* f. *incusa* Krmplhbr., loc. cit. p. 125.—*Peltigera canina* var. *membranacea* f. *rufa* Krmplhbr., loc. cit. p. 124.—*Peltigera malacea* var. *crispa* Th. Fr., Nova Acta Reg. Soc. Scient. Upsal. Ser. 3, 3: 144, 1861.—*Peltigera rufescens* var. *inflexa* Kicks., Flore Cryptog. Flandres I, 215, 1867.—*Peltigera canina* var. *ulorrhiza* f. *crispa* Hepp, Flecht. Europ. No. 850, 1867.—*Peltigera canina* subsp. *rufescens* Th. Fr., Handl. K. Svensk. Veten. 25, 1867.—*Peltigera canina* f. *rufa* Rabh., Crypt. Flora von Sachsen, 2 abth. 309, 1870.—*Peltigera canina* f. *crispata* Koltz, Recueil Memoir. et Trav. Soc. Bot. Luxemburg 13: 172, 1897.—*Peltigera canina* f. *rufa* Koltz, loc. cit.—*Peltigera canina* subsp. *rufescens* subvar. *inflexa* Boist., Nouv. Flore Lich. part 2, 81, 1903.—*Peltigera rufescens* f. *inflexa* Zahlbr., Cat. Lich. Univ. III, 487, 1925 (lapsus calami).—*Peltigera aloisii* Gyel., Oestr. Bot. Zeit. 77: 222, 1928.—*Peltigera suomensis* Gyel., Magy. Bot. Lapok 28: 60, 1929.—*Peltigera rufescens* f. *albidula* Gyel., Magy. Bot. Lapok 28: 61, 1929.—*Peltigera coloradoënsis* Gyel., Nyt. Magaz. f. Naturvid. 68: 270, 1930.—*Peltigera plittii* Gyel., loc. cit.— *Peltigera canina* var. *suomensis* Räs., Annal. Mo. Bot. Gard. 20: 16, 1933.—*Peltigera plittii* f. *ornata* Gyel., Lilloa 3: 64, 1938.—*Peltigera plittii* f. *suffusa* Gyel., Lilloa 3: 64, 1938.—*Peltigera plittii* f. *subsuffusa* Gyel., Lilloa 3: 64, 1938.

Over North America the most common of the *Peltigeras* is this variety of *P. canina*. As already stated, there is such intergradation in the *P. canina* complex that in many cases the designation of a subspecific category becomes quite subjective. The extremes of the different types are clear-cut but a large number of specimens are difficult to assign satisfactorily. The var. *rufescens* plants grow under such diverse conditions that it is no wonder that they vary sufficiently to make one who is not well acquainted with them in the field think that he sees new forms or varieties.

Exsiccatae examined.—Arn. 339 (Minn); 376 (Mich, Minn); 620 (NY); 1370 (Minn); Cum. I, 117 sub *P. canina* (Y, Wel, NY, Mo, US, F, Wis); Cum. II, 38 sub *P. canina* var. *spongiosa* (NY, C); 280 sub *P. canina* (Y, NY, H, Mich, Mo, C); Desm. ed 1, ser. 1, 1243 sub *P. malacea* (NY); Elenk. 120c (F); Erb. II, 873 sub *P. scutata* (NY, C); Fellm. 70 (NY); Flagey 10 (F); 159 (F); Harm 177 (F); Howe 40 (NY, H, Mich); Kern. 2733 (Minn); Krypt. Bad. 132 sub *P. canina* a *ulorrhiza* b *crispa* (Y); 255 sub *P. canina* var. *ulorrhiza* (C); 319 sub *P. canina* var. *spuria* (Y); Macoun 82 (Y, NY, Minn, US, Wis); 90 (Y, US); 92 (Wel); 114 sub *P. poly-*

dactyla (Mo); 138 (US); Malbr. 114 (F); Malme 754 sub *P. spuria* (Wis); Merr. 184 (F); Mig. 69 sub *P. horizontalis* (H); 169 sub *P. canina* (C) Rabh. 352 (Mich); 68 sub *P. canina* (C); 421 sub *P. pusilla* (3 packets in Mich: one is *rufescens*, one is *spuria*, one is *P. polydactyla*) (C); 560 (C); R. & S. 115 (NY); Roum. 33 (NY, C); 142 (C); 143 (NY); 157 (C); Schade 344 (Wel); Schaer. 1103 (NY, F); 1104 (NY, F); 1378 (NY, F); Wartm. 457 (Minn).

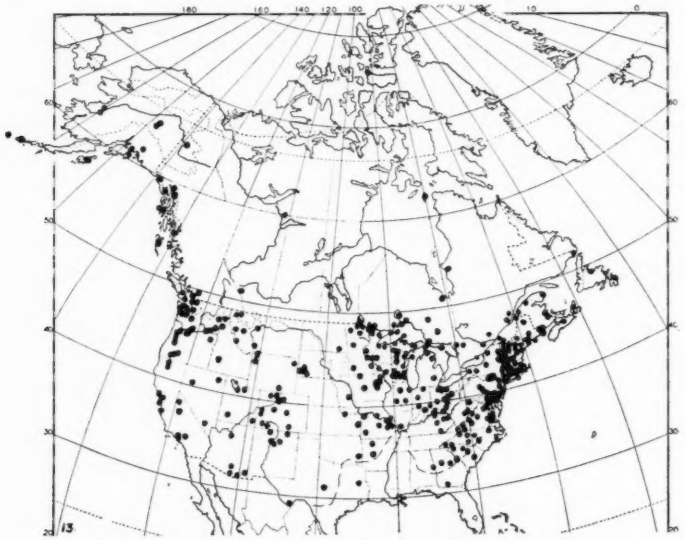

Fig. 13.—*Peltigera canina* (L.) Willd. var. *rufescens* (Weis.) Mudd.

Specimens examined.—ALASKA. Copper Center, 1933, *Thompson* (Wel); Anvik, 1937, *Osgood* (NY); St. Paul Island, 1910, *Heath* (H); Thum Bay, Knight Island, Prince William Sound, 1940, *Eyerdam* (Mich); Behrings Straits, 1858, *Wright* (F); Dawson, 1902, *Macoun* (F); Hunker Creek, 1902, *Macoun* (F); Aleutian Islands, Attu, Casco Point, 1945, *Van Schaack* (Mo); St. Paul Island, 1899, *Trelease* (Mo); Yakutat Bay, Hidden Glacier Inlet, 1899, *Trelease* (Mo); Head of Russell Fiord, 1899, *Coville & Kearney* (Mo); Cape Fox, 1899, *Trelease* (Mo); Skagway, 1939, *Eyerdam* (Mo); Muir Glacier, Glacier Bay, 1899, *Trelease* (Mo); Kodiak Island, Sturgeon River Bay, 1899, *Trelease* (Mo); Prince William Sound, Port Wells, 1899, *Trelease* (Mo); Agattu Island, 1894, *Townsend* (Mo); Juneau, 1899, *Setchell* (Mo); Sitka, 1865-66, *Bischoff* (US); Unalaska, 1880, *Bean* (US); no locality, 1867, *Kellogg* (US); Port Vita, Raspberry Strait, Raspberry Island, Kodiak Group, 1945, *Eyerdam* (Wis); Fairbanks, 1926, *Miller* (F); Holy Cross, 1905, *Palmer* (F); Cantwell, 1926, *Palmer* (T).

NORTHWEST TERRITORIES: Hudsons Straits, Mansfield Island, *Macoun* (F); Fort Smith, Lat. 60° N., Long. 110° 51′ W., 1940, *Dutilly* (Mich); Grinnell Land, *Lehnert* (Mich); northwest America, *Seeman* (NY).

BRITISH COLUMBIA: Brackendale, 1909, *Macoun* (F); 1916 (F); Sidney, Vancouver Island, 1912, *Macoun* (F); 1913 (F); New Westminster, 1904, *Hill* (F, Mo); Rocky Mt. Park, Simpson's Pass, 1913, *Sanson* (F); Bennet, 1907, *Cowles* (C); Boston Bar, Frazier River, 1865-66, *Rothrock* (US); Vancouver, *Lyall* (F); Vancouver Island, Victoria, 1893, *Macoun* (F); Chilsen, 1907, *Macoun* (F); Queen Charlotte Islands, Skidegate, 1910, *Spreadborough* (F); New Westminster, *Merrill* (F); Sandon Road near

Apex, Slocan District, 1924, *McFadden* (DA); Base of Gold Range, 1921, *no coll.* (DA); Gold Range, 1921, *Plitt* (DA); Canyon, Quartz Creek, 1921, *Plitt* (DA); Nanaimo, 1891, *Cooley* (NY).

ALBERTA: Atawan Cabin, 1929, *Brinckman* (Mich); Lake Louise, 1920, *Seifrig* (DA); Banff, 1913, *Sanson* (F); 1904, 1910 (F); Simpsons Pass, 1913, *Sanson* (F).

SASKATCHEWAN: no locality, 1859, *Bourgeau* (Wis, F).

ONTARIO: Parry Sound District, Shawanga, 1912, *Klugh* (F); Ottawa, 1891, *Macoun* (F, P); Fort William, 1912, *Jennings & Daily* (F); Middle of east shore of Orient Bay, Lake Nipigon, 1914, *Jennings* (DA); near Revillon Freres Post, north of Ombabika Bay, Lake Nipigon, 1914, *Jennings* (DA); Brant Co., Zion, 1942, *Cain* (H); Moosonee, James Bay, *Lepage* (H); Battery Bluff, Manitoulin Island, 1932, *Grassl* (Mich); Algonquin Park, 1944, *Thompson* (Mich); Tamarack Point, Manitoulin Island, 1932, *Grassl* (Mich); Cochrane, *Locher* (Mich); Martin River Camp, Rock Cliff, *Locher* (Mich); Providence Bay, Manitoulin Island, 1932, *Grassl* (Mich); Indian Point, Magnetewan, 1920, *Plitt* (DA); Porphyry Island, Lake Superior, 1913, *Jennings* (DA); Royston Park, Owen Sound, 1879, *Roy* (P); Rainy Lake, 1930, *Schmidt* (Mo); Sault Ste. Marie, 1897, *Harper* (C); Timagina Forest, Martin River, *Locher* (F); Rossport, 1912, *Jennings & Daily* (F).

QUEBEC: Ste. Anne, 1935, *Lepage* (D); Bic Co., Rimouski, 1940, *Lepage* (Mich); Knolton, 1938, *Anselm* (H); Rimouski Co., St. Fabien, 1941, *Lepage* (H); East Coast of Hudson's Bay, Fort Georges, Loon Island, *Dutilly & Lepage* (H); Lac Riles, 1938, *Lepage* (H); Pont Rouge, 1938, *Lepage* (H); Riviere du Loup, 1913, *Victorin* (NY, F); Gaspé, 1937, *Evans* (Y); Waterloo, 1936, *Anselm* (Y); La Tuque, 1936, *Anselm* (Y); Port Harrison, 1936, *Polunin* (F); Hull, 1907, *Merrill* (F); Lac Labelle, 1944, *Thomson* (T).

LABRADOR: Forteau, 1893, *Waghorne* (NY).

NEWFOUNDLAND: Grand Falls, 1911, *Fernald & Wiegand* (F); Cap a l'Aigle, 1905, *Macoun* (Mich); New Galloway, *McAndrews* (Mich); no locality, *Waghorne* (Mich); Valley of Exploits River, Grand Falls, 1911, *Fernald & Wiegand* (Wel, F), St. John's Island Bay, 1925, *Gilbert* (F).

NEW BRUNSWICK: Campobello, 1902, *Farlow* (Mich, F); Robins Hill, Chelmsford, 1843 (C); Bass River, 1872, *Fowler* (C); North Head, Grand Manan, 1922, *Taylor* (DA).

NOVA SCOTIA: Colchester Co., Upper Brookside, 1929, *Wehmeyer* (Mich); Cape Breton Island, Big Intervale, 1893, *Macour* (F); Colchester Co., Denmark, 1928, *Prince* (F); Ont. Co., Barney River Station, 1928, Prince (F).

United States. ALABAMA: Auburn, Lee Co., 1897, *Earle* (Wis); *Earle & Baker* (NY); Goldville, 1900, *Pollard & Maxon* (US); no locality, *Peters* (F). ARIZONA: Santa Cruz Co., Santa Rita Mts., 1943, *Darrow* (T); San Francisco Peaks, 1945, *Darrow* (T); Chiricahua Mts., Monument Peak, 1906, *Blumer* (Minn, NY); Cochise Co., Chiricahua Mts., 1940, *Ferris* (H); Coconino Co., Colton's Coyote Ranch, 1935, *Hedrick* (Mich, F); San Francisco Mts., 1911, *Hill* (DA); Santa Rita Mts., Madera Canyon, 1922, *Bartram* (F); Carr Canyon, Huachuca Mts., 1909, *Goodding* (NY); Huachuca Mts, 1919, *Kinn* (US); Rincon Mts., Aspen Gulch, 1909, *Blumer* (Mo); Gros Ventres Fork, 1860, *Hayden* (Mo); Rincon Mts., Manning Camp, 1909, *Blumer* (Mich, C). ARKANSAS: Mt. Judea, 1913, *Emig* (Mo); Murray, 1915, *Emig* (Mo); Conway Co., Petit Jean State Park, 1944, *Demaree* (H); no locality, 1915, *Emig* (Mo); Conway Co., Petit Jean State Park, 1944, *Demaree* (H); no locality, 1915, *Grant* (F)

CALIFORNIA: North of Clermont, 1916, *Johnson* (H); Santa Clara Co., Toyon Lodge, Saratoga, 1945, *Herre* (H); 5 miles west of Stanford University, 1903, *Herre* (H); Siskiyou Co., Mt. Shasta, 1942, *Cooke* (H); Monterey Co., Hastings Natural History Reservation, 1944, *Linsdale* (H); 1943, *Herre* (H); Sonoma Co., Kenwood, 1936, *Goff* (H); Santa Cruz Mts., Black Mt., 1904, *Herre* (Mo, F, Minn, NY); 1903, *Herre* (Mo, F, NY, H, Minn, Mich); no locality, 1864-1870, *Bolander* (C, US, Minn, NY); Sonoma Co., Adobe Canyon, 1894, *Bioletti* (C); San Bernardino Mts., Santa Anna Canyon, 1899, *Hasse* (US, F); Berkeley, 1919, *Johnson* (F); San Antonio Mts., Evey Canyon, 1916, *Johnson* (F); San Antonio Mts., Frankish Canyon, 1916, *Johnson*

(F); Yosemite Valley, 1911, *Reed* (F); Sisson, 1894, *Howe* (F); Fresno Co., Millwood, 1904, *Culbertson* (F, NY); Yosemite Valley, *Hasse* (F); 1900, *Hasse* (Minn); Los Angeles Co., San Gabriel Mts., 1902, *Hasse* (F, NY); 1896, *Hasse* (NY); Pasadena, 1910, *Kingman* (F); San Gabriel Mts., Los Flores Canyon, 1911, *Kingman* (DA); Marin Co., Larkspur, 1942, *Brown* (H); Los Angeles Co., 1897, *Hasse* (US); Los Angeles Co., San Gabriel Mts., 1915, *Moxley* (US); Oakland, 1864, *Bolander* (US, F, Mich); Shasta Co., Cow Creek, 1894, *Baker & Nutting* (H); San Mateo Co., Pilarcitos Creek, 1939, *Herre* (H); San Mateo Co., Santa Cruz Mts., King's Mt., 1930, *Herre* (H); Marin Co., Mt. Tamalpais, 1892, *Howe* (H, NY); Santa Cruz Mts., Corte Madera, 1903, *Herre* (H); San Bernardino, *Parish* (NY, F); Yosemite Park, 1900, *Bioletti* (NY, C); Mt. Lowe, 1864, *Hasse* (NY); Santa Cruz Mts., Hidden Villa, 1903, *Herre* (NY); Santa Cruz Mts., near Congress Springs, 1904, *Herre* (NY); 1907, *Herre* (F); Pasadena, *McClatchie* (NY); Sonoma Co., Cazadero, 1896, *Howe* (NY); no locality, 1888, *Lemmon* (NY); Yosemite Valley, 1868, 1869, *Bolander* (F); Yosemite, *Farlow* (F); Henness Pass, Sierra Nevadas, *Mann* (F); Santa Clara Co., Saratoga, 1945, *Herre & Macbride* (C); Los Angeles Co., Tuna Canyon, Verdugo Hills, 1932, McFadden (DA); no locality, *Lehnert* (Mich); Mill Creek Canyon, *Chace* (F).

COLORADO: Rocky Mt. Nat'l. Park, St. Vrain District, 1937, *Kiener* (Wolfe, Mich); East Portal, 1929, *Plitt* (DA); Rocky Mt., National Park, Longs Peak, 1934, *Kiener* (Mo, Mich); Longs Peak Valley, 1936, *Kiener* (Mich, Mo); Minnehaha, 1903, *Stewart* (F); Mt. Gibson foothills, 1910, *Jewett* (F); Mt. Chautauqua, Palmer Lake, 1928, *Gaidig* (F); Boulder Co., Gold Hill, 1887, *Gale* (P, US); Baltimore, 1921, *Plitt* (DA, Mich); Montrose Co., Tahequache Basin, 1914, *Payson* (Mich); Montrose Co., Naturita, 1914, *Payson* (Mich); Mt. Hesperus, 1898, *Baker & Earle* (Mich, US); Apex Road near Baltimore, 1929, *Plitt* (Mich, DA); Routt Co., Steamboat Springs, 1903, *Goodding* (Mich, Mo); Minnehaha, Pikes Peak, 1919, *Johnson* (F); Chimney Rock Mesa, Piedra, 1931, *Schmoll* (Mich); Huerfano Co., Walsenburg, 1942, *Macbride* (C); Pagosa Peak, 1899, *Baker* (NY, H); El Paso Co., summit of Pikes Peak, 1941, *Richards & Rubenstein* (C, H); Minnehaha, 1905, *Clements* (NY); North Cheyenne Canyon, 1903, *Schantz* (DA); no locality, 1912, Chaney (C); Twin Lakes, 1873, *Wolf* (C, US); Larimer Co., Twin Sisters Mt., 1938, *Kiener* (C); Grand Mesa, Lake Eggleston, 1936, *Schollerstrom* (H) (specimen very broad, up to 3 cm. across, but seems to be this).

CONNECTICUT: Plainville, *Bishop* (C); Killingworth, 1873, 1874, *Hall* (Y); 1932, 1933, *Evans* (Y); Orange, 1873, *Hall* (Y); Milford, 1931, *Evans* (Y); Guilford, 1932, *Evans* (Y); North Branford, 1932, *Evans* (Y, F); New Haven, 1923, *Castle* (Y); New Haven, Westville, 1923, *Castle* (Y); North Canaan, 1931, *Evans* (Y); New Milford, 1923, *Evans* (Y, F); Kent, 1923, *Hunt* (Y, F); Brookfield, 1927, *Evans & Musch* (Y); Brookfield, 1936, *Evans* (Y); Branford, 1928, *Evans* (Y); Madison, 1927, *Evans* (Y, F); Middlesex Co., *Clinton*, 1927, *Evans* (Y, F); Portland, 1927, *Dunlop* (Y); Lamentation Mt., Meriden, 1927, *Evans* (Y); Branford, 1924, *Nichols* (Y); New London Co., East Lyme, 1927, *Evans* (Y, F); Pock House Hill, East Hartford, 1905, *Weatherby* (Y); no locality, 1883, *Wright* (Y, F); Trap Ledges, West Rock, New Haven, 1911, *Nichols* (Y); Kent, 1936, *Evans* (Y); Goshen, 1935, *Evans* (Y); Sharon, 1932, 1936, *Evans* (Y); Marlboro, 1933, *Evans* (Y); Canton, 1933, *Evans* (Y); East Rock, New Haven, 1873, 1874, *Hall* (Y); Franklin, 1932, *Evans* (Y); Saltonstall Ridge, East Haven, 1875, *Hall* (Y); Rocky Hill, 1883, *Wright* (Y, F); Rocky Hill, 1896, *Starmer* (Y); Litchfield Co., Salisbury, 1926, *Evans* (Y, F); Wethersfield, 1882, *Wright* (Y); Newington, 1882, *Wright* (Y, F); Canaan,, 1882, *Wright* (Y, F); Harwinton, 1933, *Evans* (Y); New Haven Co., Woodbridge, 1923, *Evans* (F); Middlesex Co., East Hampton, 1927, *Evans* (F); South Canterbury, 1905, *Hadley* (DA, F); Middlesex Co., Portland, 1927, *Evans* (F); New Haven Co., Branford, 1925, *Musch* (F); Noroton, 1904, *Wright* (F); New Haven, 1909, *Graves* (F); Danbury, 1886-7, *Barnhart* (NY); Litchfield Co., Cornwall, 1926, *Evans* (F); Fairfield Co., Stamford, 1926, *Evans* (F); Central Village, 1900, *Sheldon* (F). DELAWARE: Pikes Creek, Mill Creek, 1886, *Commons* (NY); Red Clay Creek, 1851, *no coll.* (F).

DISTRICT OF COLUMBIA: *Otto Lugar* (Minn); *Lehnert* (Mich, US); Rock Creek Park, 1898, *Williams* (US). GEORGIA: Putnam Co., Eaton, 1938, *Pyron & McVaugh* (Mo); McDuffie Co., Thomson, 1908, *Bartlett* (Mich, F); De Kalb Co.,

Stone Mt., 1893, *Small* (Mich); Madison Springs, 1849, *Ravenel* (F); Thomasville, 1906, *Taylor* (F). IDAHO: Lac Pend d'Oreille, 1890, *Luberg* (NY); Latah Co., Pina Creek, 1897, *Henderson* (Wel); Moscow, 1900, *Abrams* (H); Elmore Co., Boise Nat'l. Forest, Atlanta, 1942, *McFadden* (H); Latah Co., Kendrick, 1897, *Henderson* (F). ILLINOIS: Athens, *Hall* (F, Wis); Jackson Co., Gorham, 1939, *Hubricht* (Mo, F); Jackson Co., Fountain Bluff, 1 mile south of Gorham, 1939, *Hubricht* (C); La-Salle Co., Bailey's Falls, Vermillion River, *Calkins* (C, NY); Cook Co., Glencoe, *Calkins* (C, NY, F); Canton, 1882, *Wolf* (US, P); Champaign Co., *Calkins* (C); no locality, *Hall* (C).

INDIANA: Lafayette, 1890, *Bolley* (Mich); Perry Co., Sect. 22 of Union Township, 1929, *Deam* (DA); McLean's Woods, Greencastle, 1907, *Banker* (NY); Miller, 1935, *Darrow* (Y); Crawford Co., southeast of Mifflin, 1932, *Deam* (DA); Franklin Co., Peppertown, 1937, *Deam* (H); Brookville, 1882, *Meyncke* (P); Bartholomew Co., Stoney Lonesome, 1935, *Friesner* (T). IOWA: Decorah, 1882, *Holway* (P); Estherville, 1917, *Wolden* (DA); Iowa Co., Homestead, 1939, *Kiener* (NY, C, F); Fayette Co., 1893, *Fink* (Mich, Wis, Minn, F, Mo, US, NY); 1894, *Fink* (Mich, Mo, F); Boone Co., The Ledges, 1903, *Fink & C.M.K.* (Mich); LaPorte, 1896, *Peck* (Mich). KANSAS: St. George, 1893, Botanical Club Kas. State Agr. Coll. (NY); Fort Scott, 1892, *Bennett* (NY). KENTUCKY: Bath Co., Olympia, 1941, *Allen* (NY, Mo, Mich); Whitley Co., Cumberland Falls, 1941, *Allen* (NY, Mo); Conway, 1919, *Fink* (F, NY, D); Bath Co., Knob Licks, 1941, *Allen* (Mo); Carter Co., Tygart Creek, 1932, *Fulford* (Y); Boone Co., Woolper Creek, 1931, *Fulford* (Y). LOUISIANA: no locality, *Hale* (F).

MAINE: Manchester, *Sargent* (US); Mt. Desert Island, Green Mt., 1922, *Plitt* (DA); Cumberland, 1857, *Blake* (Mich, NY); Muddy Pond Woods, 1882, *Faxon* (F); Waldo Co., Freedom, 1924, *Parlin* (F, Mich); 1922, *Parlin* (F); Oxford Co., Howard Hill, South Hartford, 1935, *Parlin* (Mich, Y, F, T); 1940, *Parlin* (T); Hartford, 1940, *Parlin* (T); Oxford Co., Greenwood, 1945, *Parlin* (T); Franklin Co., Jay, 1945, *Parlin* (T, F); Franklin Co., Eustis, 1931, *Parlin* (DA); Oxford Co., Hartford, 1931, *Parlin* (DA); Hamlin, 1914, *Norton* (F); Oxford Co., Buckfield, 1931, *Parlin* (Y); Rockport, *Merrill* (C); Knox Co., 1904, *Merrill* (Mich); Portage, 1907, *Riddle* (F); Oldtown, 1907, *Riddle* (F); Rangeley, 1904, *Riddle* (F). MARYLAND: Glenburne, *Plitt* (F); Baltimore Co., Gunpowder River, 1910, *Plitt* (F, DA); Baltimore Co., Green Spring Valley, 1910, *Plitt* (F, DA); Anne Arundel Co., Round Bay, 1910, *Plitt* (F); Baltimore Co., Petuxent River, 1910, *Plitt* (F); 1907, *Plitt* (DA); Montgomery Co., Plummers Island, 1934, *Leonard* (US); 1907, *Fink* (US); 1932, *Leonard & Killip* (US); 1903, *Maxon* (US); no locality, 1905, *Plitt* (DA); no locality, 1911, *Plitt* (DA); Catonville, 1905, *Plitt* (F); Anne Arundel Co., path from Annapolis Road to Old Furnace, 1905, *Plitt* (DA); Baltimore Co., on Merry Mans Mills Road near Gunpowder River, 1905, *Plitt* (DA).

MASSACHUSETTS: New Bedford, *Willey* (US, Minn, C, Mo); Waltham, *Mann* (US); Concord, 1863, *Mann* (C); Lanesboro, 1910, *Riddle* (F); Wellesley, 1908, *Riddle* (F); Pepperell, 1909, *Riddle* (F); Wellesley, 1884, Cummings (Wel, Mich, US); Waltham, 1893, *Burt* (Mich, F); Ellis, 1900, *Clinton* (Y); Mt. Washington, 1932, *Evans* (Y); Lunnenburg, 1883, *Sargent* (F); Reading, 1912, *Kingman* (F); New Bedford, *Clarke* (F); Waltham, 1893, *Jones* (Mich); Hingham, *Russell* (C); Cambridge, *Tuckerman, Jr.* (NY); Cambridge, 1839, *Tuckerman* (F); Needham, 1843, *Tuckerman* (F); Springfield, 1895, *Sweetser* (Mo); Boston, 1878, *Edwards* (NY); Prospect Hill, Waltham, 1897, *Kingman* (NY). MICHIGAN: Keweenaw Co., Cliff Mine, West Mt., Cooper Harbor, Fort Wilkins, Delaware Mine, Hebard Park, Manganese River, 1947, *Thomson* (Wis); Isle Royale; Rock Harbor, 1904, *Harper* (C); Isle Royale, Rock Harbor, 1930, *Lowe* (DA, F, Mich); Isle Royale, Tobin Harbor, 1930, *Lowe* (NY); Isle Royale, 1909, *Cooper* (Minn); Isle Royale, 1901, *Stuntz & Allen* (Wis); Isle Royale, Outlet of Siskowit Lake, 1930, *Lowe* (Wis, F, Mich); Deerton, Laughing Whitefish Point, 1933, *Lowe* (Mich, F, DA); Emmet & Cheboygan Cos., vicinity of Burt & Douglas Lakes, 1923, *Nichols* (Mich); *Leeson* (F); Cheboygan Co., Biological Station, 1931, *Miner* (Mich); Porcupine Mts., 1923, *Darlington* (Mich, DA); Beaver Lake, 1916, *Macoun* (F); Neebish, 1919, *Harper* (C); Ann Arbor, 1893, *L.N.J.*

(Mich); Harbor Springs, 1931, *Mains* (C, NY, Mich); Prentis Bay, 1923, *Nichols* (F, Mich, Y); Colonial Point, 1923, *Nichols* (F, Mich, Y); Bald Mt., Big Bay, 1933, *Lowe* (DA, Mich, F); Cecil Bay (Emmet or Cheboygan Co.), 1923, *Nichols* (F); 1920, *Nichols* (Y); Sault Ste. Marie, *Devart* (F); Menominee Co., Menominee River road, 1933, *Grassl* (Mich); Big Stone Bay, 1922, *Nichols* (Y); Isle Royale, Tobin Harbor, 1942, *Bailey* (Mich); Au Train Falls, Au Train, 1933, *Lowe* (NY); George Preserve, Pinckney, 1931, *Mains* (Mich); Pinckney, 1930, *Smith* (Mich); Chippewa Co., Homestead, Sugar Island, 1935, *Hermann* (Mich); Munising, 1933, *Lowe* (F).

MINNESOTA: Whitefish Lake, 1891, *Dewart* (F); Grand Portage Isle, 1902, *Fink* (F); Warroad, 1901, *Fink* (NY); no locality, 1896, *Fink* (F); Taylors Falls, 1896, *Fink* (Mich); Minneapolis, 1896, *Fink* (Mich, Minn); Bemidji, 1900, *Fink* (Minn); Shoal Lake Island, 1894, Sheldon (Minn); Oak Island, 1901, *Fink* (Minn); Rainy Lake City, 1901, *Fink* (Minn); Beudette, 1901, *Fink* (Minn); Emo, 1901, *Fink* (Minn); Vermilion Lake, 1886, *Arthur* (Minn); Battle Lake, 1900, *Fink* (Minn, US); Granite Falls, 1899, *Fink* (Minn); Kettle Falls, 1901, *Fink* (Minn); Koochiching, 1901, *Fink* (Minn); Harding, 1901, *Fink* (Minn); Thief River Falls, 1900, *Fink* (Minn); Red Lake, 1900, *Fink* (Minn); Lake of the Woods, 1896, *Sheldon* (Minn); Tower, 1901, *Fink* (Minn); Leaf Hills, 1900, *Fink* (Minn); Henning, 1900, *Fink* (Minn); Winona, 1890, *Holzinger* (NY); Winona, 1939, *Conard* (H); Northfield, 1903, *Marsh* (Wis); Superior Nat'l. Forest, 1930, *Denniston* (Wis).

MISSOURI: Independence, 1894, *Bush* (Mich, Mo); Midway, 1906, *Schantz* (DA); St. Louis, *Hall* (C); Iron Co., Shepherd Mt., 1898, *Russell* (Mo, Mich); Shepherd Mt., Ozarks, 1906, *Nelson* (F), Meramec Highlands, 1907 *Nelson* (F); Ste. Genevieve Co., Beckett Hills, 1941, *Hubricht* (Mo); Iron Co., Ironton, 1898, *Russell* (Mo); Jefferson Co., Festus, *Berry* (Mo); Meramec Highlands, 1910, *Craig* (Mo); Ste. Genevieve Co., Terre Bleue Creek, 1897, *Trelease* (Mo); Jasper Co., Carthage, 1898, *Trelease* (Mo); Phelps Co., Meramec Spring, 1898, *Trelease* (Mo); Silica, 1899, *Trelease* (Mo); Seligman, 1892, *Dewart* (Mo); Ste. Genevieve Co., River aux Vases, 1932, *Moore* (Mo); Franklin Co., Grays Summit Arboretum, 1936, *Berry* (Mo); Creve Coeur, 1914, *Emig* (Mo); Cliff Cave, 1903, *Nelson* (F). MONTANA: Marysville, 1931, *Flint* (DA); Glacier Nat'l. Park, Waterton Lake, 1910, *Jones* (Mich); Alta, 1909, *Jones* (Mich); Missoula, 1897, *Elrod* (Mich); O'Kiefe Canyon, 1901, *Harris* (NY); McDonald Lake, 1901, *Harris* (NY); Sin-Yale-a-min Lake, 1901, *Harris* (NY); Sheep Rock, Bozeman, 1930, *Young* (Mich); Kalispel, 1899, *Blankinship* (Mich); Missoula, 1899, *Blankinship* (Mich); Lower Gallatin Canyon, 1898, *Blankinship* (Mich); Bridger Mts., 1897, *Bessey & Rydberg* (NY); Neihart, 1891, *Williams* (NY); Greek Creek, Gallatin River, 1931, *Flint* (DA); Spanish Basin, 1897, *Rydberg & Bessey* (C); T. 12 N., R. 9 W., 1931, *Flint* (DA).

NEBRASKA: Weeping Water, *Williams* (Mich). NEVADA: East Humbol: Mts., 1868, *Watson* (NY, F); West Humbolt Mts., 1865, *Watson* (Y); 1868, Watson (US); Kyle Canyon, Charleston Mts., 1927, *Jaeger* (F). NEW HAMPSHIRE: White Mts., *Needham* (US); Shelburne, 1897, *Farlow* (F, H); 1884, *Farlow* (?) (F); White Mts., *Tuckerman* (F); Croydon, 1935, *Thorogood* (Wel); North Woodstock, 1884, *Cummings* (Wel); Keene, *Clinton et al.* (Y); Randolph, 1927, *Sudbury* (Y); Chocorua, 1904, *Farlow* (?) (F); North Woodstock, Franconia Mts., 1892, *Cummings* (US); Muddy Pond Woods, 1882, *Faxon* (Mo); Lake Cruten, Ossipee, 1896, *Grover* (Mo); Lempster, 1927, *Butler* (C).

NEW JERSEY: no locality, *Austin* (F); Closter, *Austin* (NY, F); Atco, *Green* (US); Atco, 1886, *Eckfeldt* (US); White Lake, 1939, *Nearing* (H); Palisades, *Austin* (NY); Pasadena, 1939, *Nearing* (H); Shawngunk Mt., 1865, *Austin* (NY); Hewitt, Passaic Co., 1939, *Thomson* (Γ). NEW MEXICO: Balsam Park, Scandia Mts., 1914, *Ellis* (US, Mo, F); Jemez Mts., 1932, *Jones* (Mich); San Miguel Co., Hermits Peak, El Porvenir, 1939, *Richards & Drouet* (C, H); San Miguel Co., Pecos, 1939, *Richards & Drouet* (C, H); Las Vegas, 1926, 1929, *Arsene* (F); Ute Park, Colfax Co., 1916, *Standley* (F); Rio Arriba Co., Brazos Canyon, 1914, *Standley & Bollman* (F, US); Cloudcroft, 1932, *Jackman* (DA); Camp Stambourg, 1878, *Mayhew* (US); Santa Fe, 1848, *Fendler* (F).

NEW YORK: Penn Yan, 1852, *Sartwell* (F, NY); no locality, 1852, *Peck* (F);

Greenwich, 1865-66, *Fitch* (US); Adirondacks, Warrensburg, 1933, *Lowe* (Mich); Jefferson Co., Wellesley Island, 1902, *Robinson & Maxon* (US, F, NY); Buffalo, *Mohr* (US); Essex Co., Chilson Lake, 1901, *Harris* (US, NY, Wel); Mt. Zion, Marlborough, 1896, *Barnhart* (NY); Moriah, 1916, *Keeler* (DA); Essex Co., near Lake Champlain, 1886, *Burt* (Mich); Greenport, Long Island, 1914, *Latham* (F); Baughns, 1913, 1915, *Burnham* (F); Westchester Co., Shrub Oak, 1906, *Martens* (F); Oneida, *no coll.* (F); Heart Lake, 1935, *Darrow* (F, Mich); Long Island, 1914, *Latham* (F); Essex Co., 1886, *Burt* (F); Jefferson Co., Murray Island, 1902, *Robinson & Maxon* (US); Columbia Co., Copake Falls, 1914, *Britton* (NY); Poughkeepsie, *Gerard* (NY); Lake George, Huletts Landing, 1890, *Jelliffe* (P); Brier Ridge, 1887, *Britton* (P); Middle Granville, 1932, *Drushel* (D); Kingston, 1904, *Williams* (F); Putnam Co., Fahnstock State Park, 1940, *Thomson* (T); Essex Co., Wadhams Falls, 1886, *Burt* (F); East Hampton, Long Island, *Latham* (Mich); Lake Champlain, 1886, *Burt* (Mich).

NORTH CAROLINA: Mecklenburg Co., Charlotte, 1927, *Gray* (Mich); Tryon, 1928, *Evans* (D, F, Y); Waynesville, 1910, *Standley* (F); Winston Salem, 1921, 1923, *Schallert* (F); no locality, *Standley* (F); Roan Mt. Winston Salem, 1927, *Schallert* (DA); On Roanoke River, Weldon, *Small* (NY, C); Watauga Co., line between Blowing Rock & Linville, 1933, *Leonard* (US); Mts. (no other data), *Curtis* (F); Pilot Mt. Winston Salem, 1925, *Schallert* (DA); Nifong Rock Quarry, 1933, *Schallert* (H, Wis); Friedburg Church, Winston Salem, 1922, *Schallert* (Wis); Chapel Hill, 1937, *Evans* (Y); Columbus, 1929 *Evans* (Y); Southern Pines, 1928, *Evans* (Y); Lynn, 1928, *Evans* (Y).

NORTH DAKOTA: Kulm, 1908, *Brenckle* (F); Sheep Mt., *Brenckle* (F); Camp Pike, 1918, *Brenckle* (Mo). OHIO: Springfield, 1879, *Spence* (F); Lorain Co., Oberlin, 1892, *Bogue* (F); Columbus, 1894, *Bogue* (F); Georgesville, 1893, *Bogue* (F); Springfield, 1877, *Bogue* (O); Jackson Co., 1934, *Wolfe & Camp* (O, Wolfe); Jackson Co., 1935, *Wolfe* (Wolfe); Clark Co., Springfield, 1878, *E.J.S.* (O); Jackson Co., Rock Run, 1934, *Camp* (O); 1935, *Wolfe* (O); Knox Co., Greer, 1935, *Blaydes* (O); Columbus, Big Walnut Creek, 1907, *H.S.H.* (O); Mineral Springs, 1900, *W.A.K.* (O); Columbus, 1907, *H.S.H.* (O); Franklin Co., Columbus, 1892, *Werner* (O, F); Green Co., Clifton, 1897, *Kellerman* (O); Seneca Co., Fostoria, 1899, *Kellerman* (O); Hocking Co., 1938, *Thomas* (O); 1939, *J.W. & R.W.* (O); Wood Co., Henry Township, 1937, *Shanks* (O); Coshocton Co., north Appalachian experimental watershed, 1943, *King* (C); no locality, *Wilson* (NY); below Taylor's dam, 1840, *Lea* (P); Collinsville, 1909, *Fink* (Mich); Oxford, 1909, *Fink* (Wis); Oxford, 1927, *Fink & J.H.* (Mich); Riley, 1915, *Fink & Stout* (DA); Coshocton Co., Coshocton, 1942, *Moldenke* (DA); no locality, 1876, 1877, *Biddlecombe* (F).

OKLAHOMA: Le Flore Co., Rich Mt., 1933 (D); Beavers Bend State Park, 1946, *Chester* (D). OREGON: no locality, *Henderson* (F); Union Co., Mill Creek, 1897, *Sheldon* (F); no locality, 1871, *Hall* (F, US); Dallas, 1920, *Clency* (DA); Union Creek, 1930, *Sipe* (DA); Breitenbush, 1930, *Sipe* (DA); Corvallis, *Sipe* (DA); Portland, 1888, *Underwood* (NY); Crater Lake Nat'l. Park, 1941, *Sipe* (H); 1943, *Sipe* (H); Eugene City, *Collier* (F); no locality, 1899, *Barber* (F); Yamhill River, 1880, *Summers* (F) Eugene, 1932, *Sipe* (Mich); Corvallis, 1917, *Anderson & Gilbert* (Mich); Mt. Hood, 1907, *Frye* (Wel); Gopher Valley, McMinniville, 1880, *Summers* (P); Coast Mts., *Summers* (P); Dallas Co., 1920, *Clency* (DA).

PENNSYLVANIA: Buck Hill Falls, 1939, *Nearing* (H); Nockamixon, 1910, *Kaiser* (DA); Towanda, 1901, *Barbour* (Mich); Delaware Co., 1879, 1882 (*Eckfeldt* ?) (P); Bucks Co., Coopersburg, 1882 (P); Chester Co., 1880, *May* (C); Tussey Mt. near State College, 1942, *Kelly* (Mich); Lancaster City, Media Hill, 1895, *Eby* (Mo); Lancaster City, Rheinholds, 1894, *Eby* (Mo); Lancaster City, Hopewell Gorge, 1884, *Eby* (Mo); Lancaster City, Conestoga Creek, 1895, *Eby* (Mo); Mifflin Co., 1879, *Rothrock* (C); Lancaster Co., Mountville, 1889, *A.F.E.* (Mo); Lancaster City, Kessel Hill, 1895, *Eby* (Mo). RHODE ISLAND: no locality, *Bennett* (Mich). SOUTH CAROLINA: Chester, *Green* (F); Chester, 1883, *Green* (US); Chester, 1895, *Green* (F); Chester, 1894, *Green* (Mich); Catawba Falls, 1892, *Green* (NY, C); Santee Canal, 1849, *Ravenel* (F); Caesar's Head, *Ravenel* (F). SOUTH DAKOTA: Piedmont, 1892, *Pratt* (US, F); Rapid City, 1891, Williams (NY); *Skinner* (F); Pine Ridge Reservation,

1911, *Visher* (NY); Custer Co., Pringle, 1914, *Oliver* (Mich); Custer Co., Mayo 1914, *Oliver* (Mich); Roaring Luck Camp, Rapid City, 1940, *Thomson* (T). TENNESSEE: Lookout Mt., *Calkins* (F, NY, C, Minn, Wel, Mich, US).

TEXAS: Dublin, 1894, *Maxwell* (F); Brewster Co., Chisos Mts., Boot Spring, 1937, *Warnock* (Mo); Nacogdoches Co., Garrison Road, 10 miles northeast of Nacogdoches, 1941, Parks (T). UTAH: Ridge between East and West Forks, 1901, *Pammel* (Mich); no locality, *Palmer* (F); Summit Co., Beaver Creek, 1938, *Flowers* (H); Salt Lake Co., City Creek Canyon, 1938, *Flowers* (H); Salt Lake Co., Alta, 1938, *Flowers* (H): Salt Lake Co., Big Cottonwood Canyon opposite Clayton Peak, Brighton, 1936, *Parker* (Mo); San Juan Co., La Sal Creek, 5 miles west of Colorado-Utah line, 1939, *Cutler* (NY); Bear River Canyon, 186-, *Watson* (Y). VERMONT: Brandon, 1914, *Dutton* (Wis); Brandon, 1920, *Dutton* (Wis, F, Mo, C); Brandon, 1921, 1924, *Dutton* (F); Poultney, 1936, *Drushel* (US) Newfane, 1895, *Howe* (NY); East Dorset, 1896, *Grout* (F); Charlotte, 1873, *Faxon* (F); Rochester, 1920, *Dutton* (F); Leicester, 1922, *Dutton* (F); Newfane, 1935, *Evans* (Y); Guilford, 1937, *Evans* (Y); Hancock, 1928, *Evans* (Y); Higley Hill, Dolver, 1935, *Evans* (Y); Townshend, 1935, *Evans* (Y); Browley Mt., Peru, 1937, *Evans* (Y); Tadmer Swamp, Pawlet, 1913, *Dodge* (D); Middlebury, 1913, *Dodge* (D); Branford, 1932, *Drushel* (D); Middlebury, 1913, *Burt* (D); Willoughby Lake, 1884, *Faxon* (DA); Colchester, 1909, *Griffin* (F); Sharpshin Point near Burlington, 1850, *Russell* (C); Smugglers Notch, 1927, *Ottley & Ferguson* (Wel).

VIRGINIA: Fauquier Co., High Point north of Thoroughfare Gap, Bull Run Mts., 1939, *Allard* (T, US); Fauquier Co., Pond Mt., 1935, *Allard* (DA); Mountain Lake, 1937, *Diehl* (DA); Carroll Co., Hillsville, 1933, *Leonard* (US); Monterey, 1935, *Darrow* (Y); Nortonsville, 1923, *Chapman* (DA); Prince William Co., Bull Run Mts., north of Hopewell Gap, 1938, *Allard* (US); Fauquier Co., Hopewell Gap near Prince William Co. line, 1936, *Allard* (US); Prince William Co., High Point Ridge east of High Point, 1938, *Allard* (US); Fauquier Co., south of Hopewell Gap, 1933, *Allard* (US); Fauquier Co., High Point, 1938, *Allard* (US); Bedford Co., Peaks of Otter, 9 miles northwest of Bedford, 1942, *Luttrell & Goldstein* (Mo); Giles Co., near Hodges store, east of Pembroke, 1942, *Luttrell* (Mo); Giles Co., Mountain Lake Hotel, Mountain Lake, 1942, *Luttrell* (Mo); Mountain Lake, 1941, *Luttrell* (Mo); 1941, *Luttrell & Strickland* (Mo); Albemarle Co., Bacon Hollow, east of Swift Run Gap on Skyline Drive, 1942, *Luttrell & Goldstein* (Mo); Alleghany Co., 6 miles south of Covington, 1942, *Luttrell & Goldstein* (Mo); Charles City Co., 17 miles west of Williamsburg, 1942, *Luttrell & Goldstein* (Mo); Chesterfield Co., 6 miles west of Chesterfield, Court House, 1942, *Luttrell* (Mo); Chesterfield Co., east of Midlothian on Route 60, 1942, *Luttrell* (Mo); Henrico Co., 6 miles west of Richmond on Route 157, 1942 *Luttrell* (Mo); west of Richmond, 1934, *Luttrell* (Mo); King & Queen Co., Mascot, 1941, *Luttrell* (Mo); Grayson Co., White Top Mt., 1941, *Luttrell* (Mo); Sussex Co., Yale, *Luttrell & Strickland* (Mo); Prince George Co., New Bohemia, 1940, *Strickland* (Mo); Smyth Co., east branch of Walker Creek, 1892, *Small* (US).

WASHINGTON: White River, 1924, *Grant* (Wis, DA); Langley, 1923, *Grant* (Wis); 1922, *Grant* (D); Goldendale, 1909, *Foster* (F); Olympic Mts., Elwha River, 1907, *Frye* (F, Mich); Pullman, 1900, *Cotton* (F, DA); Seguim, 1915, *Grant* (F); 1916, *Grant* (DA); Olympic Mts., Steeple Peak, 1935, *Smith* ((F, C, Mich); Columbia Co., Blue Mts., 1931, *Howard* (F); Whatcom Co., Lummi Island, Puget Sound, 1916, *Moodie* (H); Whatcom Co., Mt. Baker, 1914, *Herre* (H); Wallula, 1906, *Foster* (F); no locality or date, *Sussdorf* (F); Olympic Mts., Queets River valley near Hume Glacier, 1907, *Frye* (Wel); Kitsap Co., Bremerton, 1931, *Howard* (Wel, F); Aberdeen, 1908, *Foster* (F); Marysville, 1922, *Grant* (Mich); Summit of Olympic Mts., 1915, *Grant* (DA); Spokane, *Milburge* (Mo); Mt. Constitution, 1907, *Cowles* (Mo, C).

WEST VIRGINIA. Lewisburg, 1930, *Gray* (NY, H); Cranesville, 1908, *Sheldon* (F); Cass, 1927, *Gray* (Mich). WISCONSIN: in addition to those specimens cited in the writer's paper (Trans. Wis. Acad. 38: 249-272. 1946 (1947)) on this state there should be added: Milwaukee, 1857, *Lapham* (P, F); no locality, 1882, *Wolf* (P); Hotlandale, 1925, *Denniston* (F); Door Co., Washington Island, 1898, *Burrill* (C). WYOMING: Jenny's Lake, 1901, *Merrill & Wilcox* (NY); Cummings, 1896, *Nelson* (NY, Mo); no locality, Hayden Expedit., 1872, *Coulter* (US); Teton Canyon, Hot Springs,

1872, *Coulter* (US); Yellowstone Nat'l. Park, Druid Peak, 1899, *Nelson* (NY, Mo); Medicine Bow Nat'l. Forest, Brookline Lake, 1922, *Wehmeyer* (Mich); Sundance Mt., 1896, *Nelson* (Mo).

11d. PELTIGERA CANINA var. RUFESCENS f. INNOVANS (Körb.) Thoms. Trans. Wis. Acad. Sci. 38: 265, 1947

Peltidea ulorrhiza var. *praetextata* Flk. apud Sommerf., Suppl. Flor. Lappon. 123, 1826—*Peltigera canina* var. *membranacea* f. *sorediata* Schaer., Enumer. Critic. Lich. Europ. 20, 1850 (non *Peltigera canina* var. *spuria* f. *sorediata* l. c.).—*Peltigera rufescens* f. *innovans* Körb., Syst. Lich Germ. 60, 1855.—*Peltigera rufescens* var. *praetextata* Nyl., Synops. Lich. I. 324, 1860.—*Peltigera canina* var. *coriacea* f. *sorediata Krmphbr.*, Denkschrift. Kgl. Bayer. Bot. Gesellsch. 4, 2 abth. 125, 1861.—*Peltigera rufescens* var. *innovans* Kickx. Flore Crypt. Flandres II, 215, 1867.—*Peltigera canina* var. *crispa* Flagey, Memoir. Soc. d'Emulat. Doubs. 420, 1882 (non Ach.).—*Peltigera canina* var. *limbata* Mudd, Manual Brit. Lich. 83, 1861.—*Peltigera rufescens* f. *praetextata* Flk. apud Stein in Cohn Krypt. Flor. Schlies. II, 1879.—*Peltigera canina* f. *undulata* Arn., Flora 67: 234, 1884.—*Peltigera canina* f. *vivipara* Hazsl., Magy. Birod. Zuzmo-Flor. 56, 1884.—*Peltigera canina* var. *undulata* Hue, Bull. Soc. Bot. France 41: 177, 1894.—*Peltigera praetextata* Wainio, Termeszetr. Fuzetek, 22: 306, 1899.—*Peltigera canina* var. *praetextata* Hue, Nouv. Archiv. du Museum, Ser. 4, II, 95, 1900.—*Peltigera canina* subsp. *rufescens* var. *praetextata* Boist., Nouv. Flore Lich. part 2. 81, 1903.—*Peltigera polydactyla* var. *undulata* A. Zahlbr., Cat. Lich. Univ. III, 488, 1925(lapsus calami)—*Peltigera praetextata* var. *subglabra* Gyel., apud Erichs. in Verhandl. Bot. Verein Prov. Brand. 70: 221, 1828.—*Peltigera praetextata* var. *inaequalis* Gyel., Oestr. Bot. Zeit. 77: 23, 1928.—*Peltigera praetextata* f. *lapponica* Gyel., Magy. Bot. Lapok 28: 61, 1929.—*Peltigera praetextata* var. *ilseana* K. S. K., Fedde Repert. 28: 203, 1930.—*Peltigera praetextata* f. *subglabra* Gyel., *Lilloa* 3: 64, 1938.—*Peltigera praetextata* f. *vivipara* Gyel., Lilloa 3: 64, 1938.

Experiments upon the thallus of *P. canina* and other species of the genus have served to convince me that this form and other "isidiate species" of Peltigera are but regeneration forms of the typical species. This particular form is but the regeneration of the abundant variety *rufescens* following injury to the thallus, either by crushing or by snails, insects or other animals feeding upon the thallus. It resembles the species but has flat regeneration squamules which are usually associated with the edges of the thallus or with cracks and holes in the surface. This form occurs sporadically throughout the range of the species.

Exsiccatae examined.—Anzi It. 92 (NY); Cum. II, 280 (Wel); Flagey 160 sub *P. crispa* (F); Krypt. Vind. 1547 (US); Leight 262 (F); Macoun 82 (Mo); 91 (Wel); Malme 606 (F, Wis); Mig. 169 (H); Mudd 60 (NY, F); Roum. 549 (NY); West. 217 (NY); Zahl. 232 (Mich).

Specimens examined.—BRITISH COLUMBIA: Brackendale, 1916, *Macoun* (F); Vancouver Island, Port Renfrew, *Schneider* (H).

ALBERTA: Banff, 1913, *Sanson* (F).

ONTARIO: Lake Nipigon, 1884, *Macoun* (F).

QUEBEC: Ste. Anne, 1935, *Lepage* (D); Waterloo, Shelford Mt., 1938, *Anselm* (H).

United States. ARKANSAS: Hot Springs, 1898, *Trelease* (Mo); Rich Mt., 1898, *Trelease* (Mo). CALIFORNIA: San Bernardino Co., San Gabriel Mts., San Antonio Canyon, 1933, *Wheeler* (Mo); Pasadena, 1910, *Kingman* (F); Shasta Springs, 1894, *Howe* (F, H, US); Santa Cruz Mts., Black Mt., 1904, *Herre* (H); Placer Co., Colfax, 1933, *Copeland* (D). CONNECTICUT: Cornwall, 1893, *Green* (NY); East Haddam, 1933, *Evans* (Y); Milford, 1931, 1923, *Evans* (Y); Cornwall, 1926, *Evans* (Y), Stamford, 1926, *Evans* (Y); Portland, 1927, *Evans* (Y); East Hampton, 1927, *Evans*

(Y); New London Co., East Lyme, 1927, *Evans* (Y, F); Middlesex Co., Middlefield, 1927, *Evans* (Y, F); Killingworth, 1874, *Hall* (Y). IDAHO: Elmore Co., Atlanta, 1942, *McFadden* (H). ILLINOIS: Athens, 1864, *Hall* (C); Menard Co., 1878, *Hall* (C); Canton, *Wilf* (US). INDIANA: Lafayette, 1917, *Fink* (D, NY, DA, F); Putnam Co., Greencastle, 1892, *Underwood* (NY); Jennings Co., Vernon, 1942, *Welch* (H). IOWA: Fayette Co., 1893, *Fink* (NY); Iowa Co., Homestead, 1939, *Kiener* (C, F, T). KANSAS: no locality, 1859, *Hayden* (F).

KENTUCKY: Madison Co., Big Hill, 1941, *Allen* (NY, Mo). MAINE, Androscoggin Co., Livermore Falls, 1946, Parlin (T). MARYLAND: Montgomery Co., Plummers Island, 1902, 1903, *Maxon* (US); 1903, *Maxon* (Mich). MASSACHUSETTS: Baltimore Co., Western Run, 1909, *Plitt* (F); Blue Hill, 1882, *Faxon* (Mich); New Bedford, *Willey* (C). MICHIGAN: Ann Arbor, 1929, *Kanouse* (Mich); Menominee Co., Turtle Creek, 1933, *Grassl* (Mich); Silver Lake near Pinckney, 1930, *Hedrick & Lowe* (Mich, F); Wagner Falls, Munising, 1933, *Lowe* (Mich). MINNESOTA: Warroad, 1901, *Fink* (Minn); New Ulm, 1899, *Fink* (Minn); Mankato, 1899, *Fink* (Minn); Battle Lake, 1900, *Fink* (Minn). MISSOURI: Greene Co., Turner, 1911, *Standley* (F, Mich); Perryville, 1886, *Demetrio* (NY); Meramec Highlands, 1910, *Craig* (Mo); Dunklin Co., St. Francis River, 1897, 1899, *Trelease* (Mo); Stone Co., Marble Cave, 1898, *Trelease* (Mo); Barry Co., Roaring River, 1898, *Trelease* (Mo); St. Louis Co., Valley Park, 1897, *Russell* (Mo).

NEW JERSEY: Palisades, *Austin* (NY); Darlington, 1939, *Nearing* (H). NEW YORK: Montauk, Long Island, 1927, *Latham* (Mich); Jefferson Co., Murray (Hemlock Island), 1902, *Robinson & Maxon* (NY); Columbia Co., Copake Falls, 1914, *Britton* (NY). NORTH CAROLINA: Eagle's Nest near Waynesville, 1910, *Standley* (US). OHIO: Springfield, 1927, *Fink* (Mich); Adams Co., Peebles, 1913, *Fink* (Mich); Columbus, 1907, *H.S.H.* (O); Fairfield Co., 1935, *Wolfe & Hartley* (O, Wolfe); Springfield, 1877, *Bogue* (O); Georgesville, 1894, *Wilcox* (O); Ross Co., 1937, 1938, *Wolfe* (O); Knox Co., Greer, 1935, *Blaydes* (Wolfe); 16 miles southeast of Dayton, 1911, *Jewett* (DA); Columbus, 1894, *Bogue* (F); Prospect, 1892, *Bogue* (F); no locality, *Lesquereux* (F); no locality, 1848, Lea (F). OREGON: Union Creek, *Sipe* (DA); Corvallis, 1932, *Sipe* (Mich). PENNSYLVANIA: Lancaster, Pequa Creek, 1894, *Eby* (Mo); Pike Co., Bushkill Falls, 1940, *Thomson* (T). TENNESSEE: Johnson City, *Moore* (NY).

VERMONT: Memphramagog, 1885, *Faxon* (F); Leicester, 1920, *Dutton* (Mo); Sudbury, 1913, *Dodge* (D). VIRGINIA: Chesterfield Co., Hopewell, 1941, *Luttrell* (Mo); Greene Co., Swift Run Gap, 1941, *Goldstein & Strickland* (Mo); Sussex Co., *Yale*, 1941, *Luttrell & Strickland* (Mo); Smyth Co., East Branch of Walker Creek, 1892, *Small* (Mo); Chesterfield Co., Bon Air, west of Richmond, 1941, *Luttrell* (Mo); Giles Co., Mountain Lake, 1941, *Luttrell* (Mo); Wise Co., high knob 7 miles east of Norton, 1942, *Luttrell & Strickland* (Mo); Charles City Co., 17 miles west of Williamsburg, 1942, *Luttrell & Goldstein* (Mo). WASHINGTON: Seguim, 1916, *Grant* (NY). WISCONSIN: in addition to the specimens cited by the writer in a paper (Trans. Wis. Acad. 38: 249-272. 1946 (1947)) on this state there should be added: Sawyer Co., Loretta, 1935, *Coe* (Mich); Vernon Co., southeast of Coon Valley, 1946, *Thomson* (Wis).

11e. PELTIGERA CANINA var. SPONGIOSA Tuck., Genera Lich. 38, 1872

Peltigera canina f.*spongiosa* Tuck., Synops. North Amer. Lich. I, 109, 1882.—*Peltigera canina* var. *membranacea* f. *spongiosa* Oliv.,Expos. Lich. Ouest. France I, 156, 1897.—*Peltigera canina* var. *undulata* f. *spongiosa* Harm., Bull. Soc. Scien. Nancy 31: 245, 1897.—*Peltigera canina* subvar. *spongiosa* Boist., Nouv. Flore Lich. part 2, 80, 1903.—*Peltigera canina* subsp. *spongiosa* Fink, Contrib. U. S. Nat'l. Herb. 14: 163, 1910.

This variety is similar to var. *albescens* but the rhizinae of the underside are strongly fibrillose and form a dense mat. Intermediates are found comparatively frequently but have been placed mainly in var. *rufescens*. This variety is of northern distribution, with the exception of California, just coming into the northernmost United States.

Exsiccatae examined.—Cum. I. 118 (Y, Wel, NY, Minn, Mo, US, F, Wis); Cum. II. 38 (H, Mich, Minn, Mo, US, F, Wis); Macoun 90 (NY, Mich, Minn, US); 92 (Mo); 93 (Wel, Mo, US, F).

Specimens examined.—ALASKA: Hunker Creek, 1902, *Macoun* (F); Choris Peninsula, 1923, *Palmer* (F); Wood River, 1923, *Palmer* (F); Middleton Island, 59° 30′ Lat., 1892, *Macoun* (US); "Alaska and British Northwest Territory," 1894, *Funston* (Mo); St. Paul Island, 1910, *Heath* (H).

BRITISH COLUMBIA: West side of Vancouver Island, 1909, *Macoun* (F); Vancouver, 1875, *Macoun* (F).

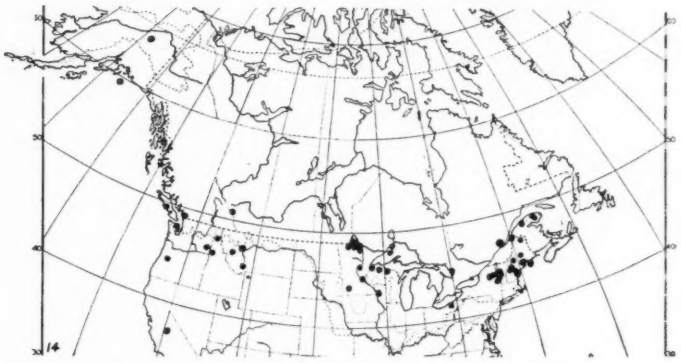

Fig. 14.—*Peltigera canina* (L.) Willd. var. *spongiosa* Tuck.

ALBERTA: Sulphur Mt., Banff, 1913, *Sanson* (F); Banff, 1901, *Bolley* (Mich); Opposite Forest Station, Highwood River District, 1928, *Brinkman* (DA).

ONTARIO: Indian Point, Magnetawan, 1920, *Plitt* (DA); 6 mile Lake northwest of Silver Islet, Thunder Cape, 1913, *Jennings* (F); Porphyry Island, 1913, *Jennings* (F); Stanley, 1913, *Jennings* (F).

QUEBEC: Ste. Anne, 1935, *Lepage* (D); Gaspé Co., Tabletop Mts., 1923, *Fernald, Dodge & Smith* (D, F); Matane Co., Riviere Cap Chat, 1923, *Collins & Dodge* (D); Kamouraska Co., Ste. Anne, 1935, *Lepage* (H); Rimouski, 1942, *Lepage* (H); Pont Rouge, 1938, *Anselm* (H).

United States. CALIFORNIA: Fresno Co., Millwood, 1904, *Culbertson* (Mo). IDAHO: Nez Perces Co., Lake Waha, 1896, *Heller* (Mo, NY, US, Minn); Lake Pend d'Oreille, 1889, *Seeberg* (P). MAINE: Oxford Co., Canton Point, 1945, *Parlin* (T); 1942 *Parlin* (T); Oxford Co., South Hartford, 1938, *Howard* (Mich); Spruce Station, Otter Cliffs, Mt. Desert Island, 1922, *Plitt* (DA); *Brownsville* (1896), Merrill (NY); Aroostoock Co., Fort Fairfield, 1893, *Cummings* (F); Mt. Fairfield, 1893, *Cummings & Teller* (F); Kingfield, 1919, *Norton* (F); Freedom, 1922. *Parlin* (F); Cumberland, 1857, *Blake* (F). MICHIGAN: Isle Royale, 1901, *Stuntz & Allen* (Mich, Wis); Isle Royale, Tobin Harbor, 1930, *Lowe* (Mich); Isle Royale, McCargo Cove, 1930, *Lowe* (Mich); Isle Royale, Siskowit Lake, 1930, *Lowe* (Mich); Isle Royale, Rock Harbor, 1930, *Lowe* (Mich, F); Isle Royale, Lake Desor, 1942, *Bailey* (Mich); Harbor Springs, 1931, *Mains* (Mich); Isle Royale, Rock Harbor, 1909, *Cooper* (Minn). MINNESOTA: Warroad, 1901, *Fink* (US, D, F, DA, Mich); Harding, 1901, *Fink* (Mich, Minn); Redwood Falls, 1899, *Fink* (Minn); Beaudette, 1901, *Fink* (Minn); Rainy Lake City, 1901, *Fink* (Minn); Koochiching, 1901, *Fink* (Minn); Oak Island, 1901, *Fink* (Minn); St. Paul, 1892, *Macoun* (P); Emo, 1901, *Fink* (Minn).

MONTANA: Avalanche Basin Trail, 1932, *Simangan* (Mich); Buffalo Horn Canyon, 1930, *Catner* (Mich); Mitten Mt. near Missoula, 1931, *Flint* (DA); near Canyon Creek, 1931, *Flint* (DA); Square Creek Ranger Station, Gallatin River, 1931, *Flint*

(DA). NEW HAMPSHIRE: White Mts., *Willey* (US); Croydon, 1935, *Thorogood* (Wel); White Mts., 1840, 1844, *Tuckerman* (F); Shelburne, Mt. Moriah, 1885, *Farlow* (F); Willoughby Mt., 1883, *Faxon* (F); North Woodstock, 1892, *Cummings* (NY); Shelburne, Mt. Monadnock (Mich). NEW YORK: Mt. Marcy, 1933, *Lowe* (Mich); Rifle Notch, 1900, *Britton* (NY); Washington Co., east of Tripoli, 1913, *Burnham* (F); Essex Co., Chilson Lake, 1901, *Harris* (US). OHIO: Ashtabula Co., Orwell, 1892, *Bogue* (F, O). OREGON: Corvallis, *Sipe* (Mich). VERMONT: Brandon, 1919, 1920, *Dutton* (F); 1920, *Dutton* (Mo); Pawlet, Tadmer Hill, 1920, *Merrill* (F); Hancock, 1928, *Evans* (Y); Pawlet, Tadmer Area, 1913, *Dodge* (D); Sudbury, 1913, *Dodge* (D); Middlebury, 1913, *Dodge* (D). WASHINGTON: Pullman, 1899, *Elmer* (H); Pullman, 1900, *Cotton* (F); Seguim, 1915, *Grant* (F). WISCONSIN: in addition to those specimens cited in the writer's paper (Trans. Wis. Acad. 38: 249-272. 1946 (1947)) in this state there should be added: Gogebic, 1939, *Evans* (Wis).

11f. PELTIGERA CANINA var. SPURIA (Ach.) Schaer., Lich. Helvet. Spicil. Sect. 6,265, 1833

Lichen spurius Ach., Lichenogr. Suec. Prodrom. 159, 1798.—*Peltidea spuria* Ach., Method. Lich. 283, 1803.—*Peltigera spuria* Lam. et D.C., Flore Franc. ed. 3, II. 406, 1805.—*Peltidea canina* var. *spuria* Ach., Lich. Univ. 518, 1810.—*Peltidea polydactyla* var. *spuria* Schlecht., Flora Berolinens. II. 84, 1824.—*Peltigera polydactyla* var. *spuria* Mann, Lich. in Bohemia Observ. Dispos. 71, 1825.—*Peltigera venosa* var. *digitata* March apud Hall, Vrolik et Mulder, Bijdrag. t. d. Natuurk. Wetensch. 5: 198, 1830.—*Peltigera canina* var. *pusilla* E. Fr., Lich. Europ. Ref. 45, 1831.—*Peltigera canina* f. *spuria* Torss., Lich. et Byssac. Scand. 8, 1843.—*Peltigera rufescens* var. *pachyphylla* f. *spuria* Flotow, 28, Jahresber. Schlesisch. Gesellsch. Vaterland Kultur, 124, 1850.—*Peltigera rufescens* f. *spuria* Körb., Syst. Lich. Germ. 59, 1855.—*Peltigera pusilla* Körb., Syst. Lich. Germ. 59, 1855.—*Peltigera rufescens* Hook., Handbook New Zealand Flora, 566, 1867 (non alior).—*Peltigera spuriella* Wainio, Acta. Soc. pro Fauna et Flora Fennica 7: 180, 1890.—*Peltigera rufescens* var. *spuria* Gyel., Bot. Köz. 24: 123, 1927.—*Peltigera behringiana* Gyel., Oestr. Bot. Zeitschr. 77: 222, 1928.—*Peltigera tereziana* Gyel., loc. cit. 220, 1928.—*Peltigera rufescens* var. *palmata* Gyel., Magy. Bot. Lapok 29: 54, 1930.—*Peltigera ponojensis* Gyel., Mem. Soc. Faun. et Flora Fennic. 8: 143, 1931.

The probability that the variety *spuria* is but an ecological or growth phase of *P. canina* has already been discussed. The pusilloid shape of the thallus seems to be the only constant character distinguishing this variety from other varieties of *canina*. This is scarcely of value in delimiting species as all gradations are to be found in the field so that this "species" is reduced to the rank of variety.

Exsiccatae examined.—Arn. 1548 sub *P. rufescens* f. *spuria* (Mich, Minn); Cum. I, 120 (NY, Mich, US, Wel); Desm. ed. I, ser. I, 730 (NY); Flagey 158 (F); Howe 30 (NY, H, F); Kern. 1540 sub *P. pusilla* (Minn, US); Krypt. Bad. 319 sub *P. canina* var. *spuria* (C); Macoun 95 (NY, US, F); Malme 507 (F, Wis); Mig. 118 sub *P. spuria* (H); Moug. 837 (NY); Rab. 421 sub *P. pusilla* (C); Wartm. 667 sub *P. pusilla* (Minn).

Specimens examined.—ALASKA: Fairbanks, *Palmer* (F); Choris Peninsula, 1923, *Palmer* (F); Camden Bay, 70° N, 145° W, 1913, *Johansen* (F).

BRITISH COLUMBIA: Queen Charlotte Islands, Skidegate, 1910, *Spreadborough* (F, Mo); Brackendale, 1916, *Macoun* (F); no locality, 1875, *Macoun* (F).

ALBERTA: Banff, 1916, *Sanson* (F).

MANITOBA: Winnipeg, 1926, *Scott* (Mich).

ONTARIO: Timagami, Martin River, *Locher* (Mich); Lake Nipigon, 1914, *Jennings* (F); Jellicoe, 1917, *Jennings* (DA); northwest of Renefrew, 1939, *Thomson* (T).

QUEBEC: Waterloo, 1937, *Anselm* (Y); Roberval, 1894, *Barnhart* (NY); Knolton, 1938, *Anselm* (H); Perce, Gaspé, 1907, *Merrill* (F); St. Fabrian, 1907, *Collins & Fernald* (F); Lake Temiscouata, 1902, *Victorin* (F).

NEWFOUNDLAND: no locality, 1892, *Waghorne* (P).

NOVA SCOTIA: Halifax Co., Shubenacadie Grand Lake, 1928, *Prince* (F).

NEW BRUNSWICK: Campobello, 1898, *Farlow* (F).

United States. CALIFORNIA: no locality, *Bolander* (F); Ventura Co., Matilija Canyon, 1903, *Hasse* (F, US); Yosemite, 1900, *Hasse* (F); San Bernardino, 1893, *Parrish* (NY); San Benardino Co., Bluff Lake, San Bernardino Mts., 1895, *Parish* (NY). COLORADO: Larimer Co., Twin Sisters Mt., 1938, *Kiener* (C); North Cheyenne Canyon, 1895, *Bessey* (NY). CONNECTICUT: Noroton, *Lowe* (DA); Rocky Hill, 1883, *Wright* (F); Newington, 1882, *Wright* (F); Hartford Meadow, 1882, *Wright* (F) Weathersfield, *Wright* (F). DELAWARE: Red Clay Creek, 1857, *Farlow* (NY). DISTRICT OF COLUMBIA: *Otto Lugar* (Minn); Plummers Island, 1934, *Leonard* (Mich). FLORIDA: Tallahassee, 1891, *no. coll.* (F); Chattahooche, 1897, *Tracey* (F, NY). IDAHO: Latah Co., Julietta, 1897, *Henderson* (Wel); Greer, 1920, *Stillinger* (DA); Moscow, 1900, *Abrams* (H). ILLINOIS: 1878, *Hall* (Mo, C). IOWA: Boone Co., The Ledges, 1903, *Fink & C.M.K.* (Mich). MAINE: Casco Bay, Orro Island, 1923, *True* (DA); Oxford Co., Buckfield, 1935, *Parlin* (NY); Oxford Co., Hartford, 1931, *Parlin* (T); Oxford Co., Canton Point, 1943, *Parlin* (F, T); Warren, 1913, *Merrill* (F). MARYLAND: Anne Arundel Co., Round Bay, 1910, *Plitt* (DA). MASSACHUSETTS: Cambridge, 1838, *Tuckerman* (F); Sudbury, 1905, *Carr* (F); Cambridge, 1890, *Underwood* (NY); Middlesex Falls, Medford, 1890, *Underwood & Seymour* (NY); Arlington, 1893, *Jones* (Mich). MICHIGAN: Isle Royale, trail between Rock Harbor Lodge and Tobin Harbor, 1942, *Bailey* (Wis); Laughing Whitefish Point, Deerton, 1933, *Lowe* (Mich); Emmet & Cheboygan Cos., Burt & Douglas Lakes, 1923, *Nichols* (F).

MINNESOTA: Grand Portage Island, 1897, *Fink* (Mich, Minn, F); Grand Portage Island, 1902, *Fink* (NY, D, DA); Minneapolis, 1896, *Fink* (US); Harding, 1901, *Fink* (Minn); Tower, 1901, *Fink* (Minn); Rainy Lake City, 1901, *Fink* (Minn); Koochiching, 1901, *Fink* (Minn); Emo, 1901, *Fink* (Minn); Oak Island, 1901, *Fink* (Minn); Beudette, 1901, *Fink* (Minn); Bemidji, 1900, *Fink* (Minn); Battle Lake, 1900, *Fink* (Minn); Red Lakes, 1900, *Fink* (Minn); Thief River Falls, 1900, *Fink* (Minn); Leaf Hills, 1900, *Fink* (Minn); Carlton Co., Carlton, 1942, *Thomson* (T); Grand Portage Island, Mt. Josephine, 1897, *Fink* (Minn); Palisades, 1897, *Fink* (Minn); Beaver Bay, 1897, *Fink* (Minn); Gunflint, 1897, *Fink* (Minn); Snowbank Lake, 1897, *Fink* (Minn); Massacre Island, Lake of the Woods, 1894, *Sheldon* (Minn); Duluth, 1893, *Harper* (C); Two Harbors, 1893, *Harper* (C); Collegeville, 1908, Hansen (F); Elmer Point, Lake of the Woods, 1894, *Sheldon* (Minn); Minneapolis, 1896, *Fink* (Minn). MISSOURI: Sulphur Springs, 1904, *Nelson* (F). NEW JERSEY: no locality, *Austin* (F). NEW MEXICO: Las Vegas, 1929, *Arsene* (F). NEW YORK: Jefferson Co., Murray Island, 1902, *Robinson & Maxon* (F); Ulster Co., Mapanock, 1921, *House* (F); Syracuse, 1889, *Underwood* (NY); Michigan Hollow, Danby, 1939, *S. M. Thomson* (T).

OHIO: Springfield, 1877, *Biddlecombe* (F); Georgeville, 1892, *Bogue* (F). OREGON: Mt. Hood, 1930, *Sipe* (DA); Elk Mt., 1897, *Sheldon* (US, Wel). SOUTH CAROLINA: Santee Canal, 1846, *Ravenel* (F). VERMONT: Barnard, 1906, *Clapp* (F); Sherburne, 1922, *Dutton* (F); Charlotte, 1908, *Riddle* (F). WASHINGTON: Brown Island, Puget Sound, 1906, *Fink* (Wel, Mich); Kitsap Co., Bremerton, 1930, *Howard* (Wel); Langley, 1921, *Grant* (DA); 1924, *Grant* (C); 1923, *Grant* (Wis); Marysville, 1927, *Grant* (DA); Puget Sound, Olga, 1906, *Fink* (Mich); Mason Co., Wallula, 1904, *Foster* (F); Seguim, 1916, *Grant* (F); Montesano, 1919, *Grant* (F). WEST VIRGINIA: Pocahontas Co., Spruce, 1927, *Gray* (Mich); Edray, 1930, *Gray* (DA, H, NY). WISCONSIN: in addition to those specimens cited by the writer in a paper (Trans. Wis. Acad. 38: 249-272. 1946 (1947)) on this state there should be added: no locality, 1857, *Lapham* (F). WYOMING: Camp Stambourg, 1878, *Mayhew* (F); Big Horn Mts., 1940, *Thomson* (T).

11g. PELTIGERA CANINA var. SPURIA f. SOREDIATA Schaer., Enumer. Critic. Lich. Europ. 20, 1850

Peltidea erumpens Tayl., In Hook. London Jour. of Bot., 6: 184, 1847.—*Peltigera canina* var. *sorediifera* Schaer., Lich. Helvet. Spicil. Sect. 6, 265, 1833.—*Peltigera canina* var. *soreumatica* Flotow, 28 Jahresber. Schlesisch. Gesellsch. für Vaterland Kultur. 124,

1850.—*Peltigera leptoderma* Nyl., Synops. Lich. I. 325, 1860.—*Peltigera canina* var. *notata* Th. Fr., Kgl. Svensk. Vetensk. Akad. Handl. 7: 15, 1867.—*Peltigera canina* var. *extenuata* Nyl. apud Wainio, Meddel. Soc. Fauna et Flora Fennica 5: 49, 1873.—*Peltigera ulcerata* Müll. Arg., Flora 63: 261, 1880.—*Peltigera extenuata* Wainio, Meddel. Soc. Fauna et Flora Fennica 6: 129, 1881.—*Peltigera rufescens* f. *sorediata* Cliv., Flore Lich. Orne I. 92, 1882.—*Peltigera rufescens* var. *vulnerata* Müll. Arg., Flora 65: 305, 1882.—*Peltigera pusilla* var. *vulnerata* Müll. Arg., Flora 69: 133, 1888.—*Peltigera erumpens* Wainio, Etud. Lich. Bresil 182, 1890.—*Peltigera spuria* var. *erumpens* Harm., Bull. Soc. Science. Nancy, Ser. 2, 31: 248, 1897.—*Peltigera canina* var. *erumpens* Hue, Nouv. Archiv. du Museum, Ser. 4, 2: 96, 1900.—*Peltigera canina* subsp. *rufescens* subvar. *sorediata* Boist., Nouv. Flore Lich. part 2, 81, 1903.—*Peltigera canina* f. *cyatheum* Norm., apud Lynge, Bergens Museums Aarbog 9: 109, 1910.—*Peltigera sorediata* Fink apud Corringt., Ohio State U. Bull. 25: 356, 1921.—*Peltigera canina* f. *sorediifera* A. Zahlbr., Cat. Lich. Univ. III. 464, 1925.—*Peltigera Hazslinszkyi* Gyel. apud Anders Die Strauch und Laub Flecht. Mitteleurop. 44, 1928.—*Peltigera erumpens* f. *glabrescens* Gyel. apud Erichs., Verhandl. Bot. Verein. Prov. Brandenbourg 70: 219, 1928.—*Peltigera leptoderma* var. *brasiliensis* Gyel., Oester. Bot. Zeitschr. 77: 224, 1928.—*Peltigera erumpens* f. *densa* Gyel., Magy. Bot. Lapok 28: 61, 1929.—*Peltigera erumpens* f. *scabrida* Gyel., Magy. Bot. Lapok 28: 61, 1929.—*Peltigera vainioi* Gyel., Magy. Bot. Lapok 28: 61, 1929.—*Peltigera erumpens* f. *leptoderma* Scholander, Nyt. Magazin for Naturvid. 73: 52, 1933.

Discussion of this form as a growth stage has already been made. The rounded spots bearing coarse gray soredia are the diagnostic character for this form. Other characters are more variable; the shape varying from tiny and cochleate to spuria-like, the amount of tomentum on the upper surface varying in amount, and the type and amount of rhizinae on the undersurface is also variable. Examination of colonies in the field leads one to reject the spate of forms, varieties and species proposed by some authors.

Exsiccatae examined.—Arn. 321 (NY); Arn. Mon. 424 sub *P. canina* var. *soreumatica* (Minn, Mich); Cum. I. 119 (Mo, US, C, Wel, NY, H, Mich, Y, Wis, F); Cum. I, 120 sub *P. canina* var. *spuria* but some packets are sorediate (Mo, US, NY, Y, Wis); Elenk. 181 sub *P. erumpens* (F); Harm. 320 (F); Howe 30 sub *P. canina* var. *spuria* (Mich); Krypt. Vind. 2056 sub *P. erumpens* (Wel, NY); Lojk. Univ. 222 sub *P. extenuata* (US, Wel, NY); Macoun 95 (Mo, Wel); Malme 934 sub *P. erumpens* (Wis, F); Mig. 118 sub *P. spurina* (Mich); Mig. 330 sub *P. erumpens* (C, NY); Rel. Tuck. 75 (Wel, Mich, Y, T); Suza 36 sub *P. erumpens* (F); Thoms. 27, 52; Zahl. 28 sub *P. erumpens* (NY).

Specimens examined.—ALASKA: Sitkalidak Island, 1932, *Eyerdam* (Mich, F, DA, Wis); Camden Bay, 70° N., 145° W., 1913, *Johansen* (F); Behring Straits, 1858, Wright (F); St. Paul Island, 1897, *Macoun* (US).

ALBERTA: Banff, 1915, *Sanson* (F); Banff, 1916, *Sanson* (F).

ONTARIO: Lake Nipigon, Orient Bay, 1914, *Jennings* (F); Rock Cliff, Martin River Camp, *Locher* (Mich); Mackenzie, 1891, *Dewart* (F, Mich).

QUEBEC: Montreal, 1904, *Dupret* (F); Gaspé, 1907, *Merrill* (F); Montmorency Falls, 1905, *Macoun* (F); Cap a l'Aigle, 1905, *Macoun* (F); Gaspé, 1937, *Evans* (Y); LaTuque, 1936, *Anselm* (Y).

LABRADOR: L'Ainse au Clair, 1899, *Waghorne* (US).

United States. CALIFORNIA: San Bernardino Mts., *Parish* (F); no locality, *Bolander* (F, US); Oakland, 1864, *Bolander* (F); Santa Monica, *Hasse* (F); San Antonio Mts., 1916, *Johnson* (F); Searsville Redwoods, 1865, *Bolander* (US); Berkeley, Garber Park, 1932, *Herre* (H); Claremont, 1916, *Johnson* (H); Sonoma Co., Kenwood, 1938, *Baker & Koch* (H); Sisson, 1909, *Pendelton* (Wel).

COLORADO: Larimer Co., Twin Sisters Mt., 1938, *Kiener* (T, NY, C); Boulder Co., Longs Peak, Chasm Gorge, 1937, *Kiener* (C); Longs Peak Valley, 1935, *Kiener* (Mich). CONNECTICUT: New Haven Co., Branford, 1925, *Musch* (F); New Haven Co., Madison, 1927, *Evans* (F, Y); New London Co., East Lynne, 1927, *Evans* (F, Y); Stony Creek, Branford, 1925, *Musch* (Y); Sharon, 1936, *Evans* (Y); Salisbury,

1935, *Evans* (Y); Granby, 1930, *Evans* (Y); Old Lyme, 1930, *Evans* (Y); North Branford, 1931, *Evans* (Y); Lebanon, 1933, *Evans* (Y); Goshen, 1935, *Evans* (Y); Canaan, 1931, *Evans* (Y); East Haven, 1925, *Evans* (Y).

DISTRICT OF COLUMBIA: *Lehnert* (Mich). ILLINOIS: no locality, *Hall* (F); Athens, 1878, *Hall* (Minn, Mich); Menard Co., 1878, *Hall* (C). IOWA: Fayette Co., 1894, *Fink* (Wis, NY, Mich, Minn, Mo, F); Iowa Co., near Homestead, 1939, *Kiener* (C). MAINE: St. Francis, 1901, *Upton* (NY); Paris, 1932, *Radu* (DA, Mich); Franklin Co., Farmington, 1929, *Parlin* (DA); Rockland, 1909, *Merrill* (F); Camden, 1912, *Crockett* (F); Aroostoock Co., Van Buren, 1893, *Cummings* (F); Winslow, 1915, *Morton* (F); Westbrook, 1908, *Norton* (F); Oxford Co., Canton Point, 1944, *Parlin* (T); Washington Co., Machias, 1922, *Parlin* (F). MARYLAND:: Plummers Island, 1907, *Fink* (Mich, US); Montgomery Co., Receiving Reservoir, 1912, *Miller* (US, F); Town Creek west of Hancock, 1940, *Thomson* (T). MASSACHUSETTS: New Bedford, 1884, *Willey* (US); Mt. Graylock, 1908, *Burnham* (F); South Framingham, 1904, *Harris* (Mich).

MICHIGAN: Keweenaw Co., Cliff Mine, 1947, *Thomson* (Wis); Isle Royale, Siskowit Lake, 1930, *Lowe* (F, Mich); Isle Royale, Hay Bay, 1930, *Lowe* (Mich, DA); Isle Royale, Tobin Harbor, 1930, *Lowe* (Mich); Au Train Falls, Au Train, 1933, *Lowe* (Mich, DA, F); Marquette, Sugarloaf Mt., 1933, *Lowe* (Mich). MINNESOTA: Carlton Co., 1 mile north of Carlton, 1942, *Thomson* (T); Rainy Lake City, 1901, *Fink* (DA, F, US, Minn, D, NY); Mankato, 1899, *Gardner* (NY); Minneapolis, 1896, *Fink* (Mich, Minn); Misquah Hills, 1897, *Fink* (Mich, Minn); Homer, 1890, *Holzinger* (US); Beudette, 1901, *Fink* (Minn); Oak Island, 1901, *Fink* (Minn); Mankato, 1899, *Fink* (Minn); Koochiching, 1901, *Fink* (Minn); Warroad, 1901, *Fink* (Minn); Leaf Hills, 1900, *Fink* (Minn); Red Lake, 1900, *Fink* (Minn, F); Battle Lake, 1900, *Fink* (Minn); Beaver Bay, 1897, *Fink* (Minn); Tofte (Carlton Peak), 1897, *Fink* (Minn); Ely, 1897, *Fink* (Minn); Snowbank Lake, 1897, *Fink* (Minn); Beaver Bay, Thief River Falls, 1900, *Fink* (Minn); Bemidji, 1900, *Fink* (Minn); New Ulm, 1899, *Fink* (Minn); Gunflint, 1897, *Fink* (Minn); Big Island, Lake of the Woods, 1894, *Macmillan* (Minn); Granite Falls, 1899, *Fink* (Minn); Emo, 1901, *Fink* (Minn).

MISSOURI: Franklin Co., Rankin Estate, 1932, *Dodge* (Mo). MONTANA: no locality, 1887, *Anderson* (US). NEBRASKA: Lancaster Co., 9 miles northwest of Lincoln, 1942, *Kiener* (T, NY); Florence, 1899, *Sheldon* (F); Sarpy Co., south of Melia, 1940, *Kiener* (C). NEW HAMPSHIRE: Cheshire Co., Fitzwilliam, 1909, *Howe* (F); White Mts., 1843, 1844, *Tuckerman* (F); White Mts., 1872, *Tuckerman* (US): Mt. Washington, 1903, *Merrill* (NY). NEW JERSEY: New Brunswick, *Willey* (F); Sussex Co., Stokes State Forest, Branchville, 1940, *Thomson* (T, H); Ringoes, 1939,*Nearing* (H); Burlington Co., Indian Mills, 1940, *Thomson* (T); Ocean Co., Lakewood, 1940, *Thomson* (T). NEW MEXICO: Rio Arriba Co., Brazos Canyon, 1914 *Standley & Bollman* (Mich, F). NEW YORK: Washington Co., Fort Ann, 1918, *Burnham* (F); Jay, 1908, *Riddle* (F); Copake, 1932, *Evans* (Y); Port Washington, 1915, *Crooke* (NY); Long Island, Mattituck, 1919, *Latham* (DA); Putnam Co., Anthony's Nose, 1940, *Thomson* (T); Westkill Hollow, Catskill Mts., 1940, *Thomson* (T).

NORTH CAROLINA: Watauga Co. line between Blowing Rock & Linville, 1933, *Leonard* (US). OHIO: Oxford, 1907, *Fink* (Mich). PENNSYLVANIA: Pike Co., Bushkill Falls, 1939, *Nearing* (H); Wellsboro, 1939, *Nearing* (H); Washington Co., Charleroi, 1905, *Jennings* (F). SOUTH CAROLINA: no locality, *Calkins* (C); no locality, *Ravenel* (US); Mt. Pinnacle, 1886, *Green* (US); Santee Canal, *Ravenel* (F). VERMONT: Mendon, 1913, *Dutton* (F); Pawlet, 1913, *Dodge* (D); Ames Hill, Brattleboro, 1935, *Evans* (Y); Higby Hill, Dover, 1935, *Evans* (Y); Guilford, 1937, *Evans* (Y); Newfane, 1935, *Evans* (Y); Halifax, 1937. *Evans* (Y). VIRGINIA: Alexandria Co., Potomac River, Chain Bridge Road, 1910, *Miller* (US); Alexandria Co., Vanderwerken, 1909, *Miller* (US); Giles Co., Mountain Lake, 1941, *Luttrell* (Mo); Natural Bridge, 1884, *Green* (P).

WASHINGTON: Mt. Rainier, 1909, *Foster* (F); Yakima Co., Deadhorse Hill, 1931, *Howard* (F); Puget Sound, Orcas Islands, Olga, 1906, *Fink* (Wel, Mich); (Olympic Mts., Elwha River Valley, 1907, *Frye* (Wel); Yakima Co., American River

Camp, 1931, *Howard* (Wel); Chelan Co., Rainbow Trail, 1931, *Howard* (Wel). WEST VIRGINIA: Cranesville, 1905, *Sheldon* (F). WISCONSIN: specimens have already been cited in a paper (Trans. Wis. Acad. 38: 249-272. 1946 (1947)) by the writer on this state.

12. PELTIGERA MEMBRANACEA (Ach.) Nyl. emend. Thoms.

Bull. Soc. Linn. Normand., Ser. 4, I: 74, 1887.—*Peltidea canina* var. *membranacea* Ach., Lich. Univ. 518, 1810.—*Peltigera canina* var. *membranacea* Duby., Bot. Gallic. II, 598, 1830.—*Peltigera Szatalae* Gyel., Magy. Bot. Lapok 25: 254, 1926.—*Peltigera membranacea* f. *fibrilloides* Gyel., Magy. Bot. Lapok 28: 60, 1929.—*Peltigera membranacea* f. *subfibrilloides* Gyel., Magy. Bot. Lapok 28: 60, 1929.—*Peltigera membranacea* f. *fibrillosa* Gyel., Magy. Bot. Lapok 28: 61, 1929.—*Peltigera membranacea* var. *Szatalae* Gyel., Magy. Bot. Lapok 29: 54, 1930.—*Peltigera canina* f. *membranacea* A. Zahlbr., Cat. Lich. Univ. III: 463, 1925.

Thallus large as in *P. canina*, the lobes broad, usually 1-4 cm. broad, margins somewhat rolled under, lobes often overlapping, very thin. Upper surface smooth and usually shining, lightly arachnoid-tomentose at the margins, the tomentose zone sometimes being extremely narrow, light yellow brown to chestnut brown when dry, greenish-brown to grayish-brown when moist. Under surface light, cream to pale brown with strongly raised veins which have a finely penicillate surface, veins pale to brown; rhizinae sparse, simple but with a penicillate surface, pale to black, long, up to a cm. in length. Apothecia small, 3-6 mm. across, on extended lobules, the sides often reflexed, the margins thin, crenate, the reverse usually corticate and smooth; disk reddish to chestnut brown; hypothecium brown, hymenium hyaline to pale brown below, red-brown above; paraphyses simple, thickened and darkened at the tips to a red-brown; asci cylindrico-clavate, 9-15 x 60-80 μ, spores aciculor, 3-5 septate, 3-4 x 44-75 μ (Herre reports 3.5-5 x 40-73.5 μ and 3-7 septate).

Algal layer continuous, 25-40 μ thick; upper part of the cortex plectenchymatous, hyaline to pale brown below, brown above, 30-60 μ thick; medulla of thickly interwoven hyphae 8-10 μ in diameter with a lumen of 4-8 μ; hyphae of veins smaller and thicker walled, about 7 μ in diameter with a lumen of 2-3 μ; medulla 70-110 μ thick. Hymenium 90-100 μ thick; hypothecium 20-60 μ thick. Algae 3-5 μ in diameter.

Reactions: K minus, C minus, KC minus, P minus, I stains the asci blue, no other part being affected.

On earth, rotting logs and stumps, humus and rocks.

Reported from Europe and North America. I have seen specimens from Japan, Mexico, Costa Rica and Papua.

In North America this species is common in the west from Alaska to California and east to Montana and Colorado, but it occurs sparingly eastward through Canada to Newfoundland and New Brunswick and in New England.

Although generally placed as a variety of *P. canina* the distinctive range and the well marked characters lead me to follow Nylander in placing this as a distinct species. The thallus is much thinner than in *P. canina*, the thinness being largely due to the difference in thickness of the medullary layer, 70-110 instead of 300-500 μ thick, although the other layers are also thinner. The penicillate appearance of the veins and rhizinae, with erect hyphae forming an even fuzzy coating over the surface instead of the closely appressed hyphae

which give a smoother appearance to the underside of *P. canina*, are also a diagnostic character. This penicillate character is not of the same appearance as the fibrillose appearance of the tropical *P. canina* var. *laciniata* Merrill in which the surface is more irregular and the hyphae longer. The lobes of this latter variety or species are more linear and thicker than in *P. membranacea*, giving an altogether different appearance to the plant. A hitherto undescribed regeneration form is described below.

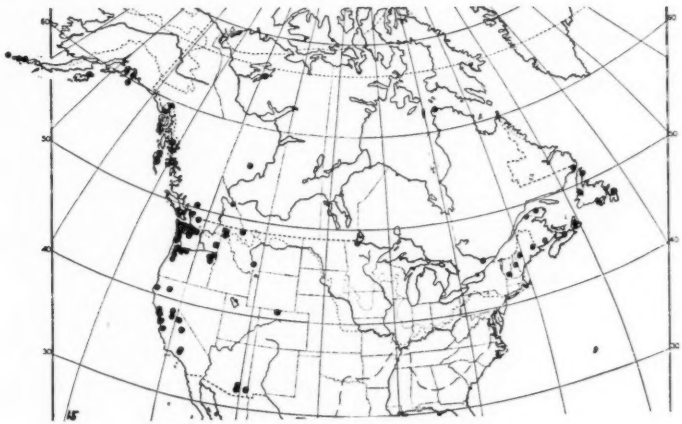

Fig. 15.—*Peltigera membranacea* (Ach.) Nyl.

Exsiccatae examined.—Bohl. 30 (NY); Cum. I 359 (Y, NY, Mich, US, Wis, F); Elenk. 120d (F); Fellm. 68 (NY); Krypt. Vind. 1547b (NY); Macoun 90 (Mo, Wis, F); 92 (US, F); 93 (NY); 94 (NY, US); Merr. 184 (Mich); Malme (881 (Wis); Mand.. 18 (NY); Moug. 154 (NY); Mudd. 59 (NY); Tuck. 74 (Y, Mich, T, F).

Specimens examined.—ALASKA: Unimak Island, 1926, *Miller* (F); Middleton Island, 1892, *Macoun* (F, Mo, NY); Unalaska, 1897, *Macoun* (F); Baranof Island, Port Armstrong, 1939, *Eyerdam* (F, Mich, NY); Unalaska Island, Captains Harbor, 1932, *Eyerdam* (F, Wis, DA, Mich); on Island in Cross Sound, 1889, *Bean* (C); no locality or date, *Kellogg* (US, P); Port Etches, Lat. 60°, 1892, *Macoun* (US, NY, Mo); Sitka, 1899, *Setchell* (Mo); Cape Fox, 1899, *Trelease* (Mo); Yakutat, 1899, *Trelease* (Mo); Unalaska, 1899, *Trelease* (Mo); St. Paul Island, 1897, *Macoun* (F); St. Paul Island, 1899, *Trelease* (Mo); Baranoff Island, Hot Springs, 1899, *Trelease* (Mo); Point Gustavus, Glacier Bay, 1899, *Coville & Kearney* (Mo); Aleutian Islands, Attu, Casco Point, 1945, *Van Schaack* (Mo); Attu, 1944, *Van Schaack* (Mo); Ketchikan, 1925, *Willett* (DA, Wel); St. George Island, 1897, *Kincaid* (Mich); Atka Island, 1932, *Eyerdam* (Mich, Wis); False Pass, Unimak Island, 1932, *Eyerdam* (Mich, Wis); Skagway, 1904, *Hess* (H); Thum Bay, Knight Island, Prince William Sound, 1940, *Eyerdam* (NY, Wis); Thum Bay, Knight Island, Prince William Sound, 1940, *Norberg* (NY, Wis); Port Vita, Raspberry Strait, Raspberry Island, Kodiak Group, 1945, *Eyerdam* (Wis); Washington Bay, Kuiu Island, 1947, *Eyerdam* (Wis).

NORTHWEST TERRITORIES: Great Slave Lake, 1826, *Richardson* (NY, F).

BRITISH COLUMBIA: New Westminster, 1902, *Hill* (Wis, NY, US, F); Queen Charlotte Islands, Massetti, 1898, *Keen* (NY, Mich); Vancouver Islands, Port Renfrew, *Schneider* (H, Mo, F); Vancover Island, Minn. Botanical Station, 1901, *Crosby* (Mich); Vancouver Island, Cape Beale, 1892, *Macoun* (P); Lowe Inlet, 1899, *Trelease* (Mo);

Vancouver Island, Broughton Strait, 1899, *Trelease* (Mo); Queen Charlotte Islands, Skidegate, 1910, *Spreadborough* (Mo, F); Nanaimo, 1891, *Cooley* (US); West Coast of Vancouver Island, 1909, *Macoun* (F); Vancouver Island, *Spreadborough* (F); Chithwait Lake, 1901, *Merrill* (F); New Westminster, 1903, *no coll.* (F); Lillooet, 1916, *Macoun* (F); Victoria, 1893, *Macoun* (F); Sear Farm, 1908 (F).

ALBERTA: Glacier, 1901, *Bolley* (Mich); Marion Lake, Lesser Slave District, 1928, *Brinkman* (DA).

ONTARIO: Ottawa, 1907, *Macoun* (F).

QUEBEC: Rimouski Co., Bic, 1940, *Lepage* (Mich, H); Bic Co., Between Mt. St. Pierre and Riviere a Claude, Gaspé, 1940, *Lepage* (Mich); Wolstenholme (south shore Hudson Strait), 1936, *Polunin* (F).

LABRADOR: Forteau, 1893, *Waghorne* (Mo, US, NY, Minn).

NEWFOUNDLAND: Birchy Cove, Bay of Islands, 1896, *Waghorne* (Mo, Minn); Miquelon Island, 1886, *Delamare* (Minn); Western Cove, 1891, *Waghorne* (P); near Topsail, Conception Bay, 1901, *Howe & Lang* (C, NY); Torbay, 1901, *Howe & Lang* (NY); St. Anthony, 1937, *Evans* (Y).

NOVA SCOTIA: no locality, *Rothrock* (C); Colchester Co., Truro, 1924, *Prince* (Mich); Pictou Co., Mt. Thom, 1931, *Wehmeyer* (Mich); Colchester Co., East Mt., Upper Brookside, 1928, *Prince* (F); Victoria Co., Big Harbor, 1928, *Prince* (F); Cape Breton Island, Braddock, 1898, *Macoun* (F).

NEW BRUNSWICK: St. John, 1877, *Fowler* (NY, US).

United States. ARIZONA: Carr Canyon, Huachuca Mts., 1909, *Goodding* (F); Rincon Mts., Manning Camp, 1909, *Blumer* (F); Chiricahua Mts., Monument Peak, 1906, *Blumer* (F, Mo). CALIFORNIA: Santa Cruz Mts., Saratoga, 1904, *Herre* (Mo, H); Santa Cruz Mts., Searsville, 1903, *Herre* (Mo); Santa Cruz Mts., Hidden Villa Canyon, 1904, *Herre* (Mo, F, H, Minn); Santa Cruz Mts., Stanford University, 1903, *Herre* (Mo); Santa Cruz Mts., Stevens Creek, 1905, *Herre* (Mo, Mich, H, DA, F, NY, Minn); Amador Co., New York Falls, 1892, *Hensen* (Mo); Santa Cruz Mts., Kings Mt., 1903, *Herre* (Mich, H, T, NY); Santa Cruz Mts., Bear Gulch Road, 1904, *Herre* (Mich); Santa Cruz Mts., 1885, *Farlow* (F, NY); no locality, 1865, *Bolander* (F); Calaveras Big Trees, Home Grove, 1906, *Dudley* (H); Sequoia Nat'l. Park, Tulare Co., 1929, *Herre* (H); Bear Gulch above Woodside, 1904, *Dudley* (H); Monterey Co., Hastings Natural History Reservation, 1944, *Linsdale* (H); Hastings Natural History Reservation, School Hill, 1943, *Linsdale* (H); Sonoma Co., East of Plantation, 1939, *Koch* (H); Marin Co., San Rafael, 1943, *Brown* (H); Marin Co., Fairfax, 1942, *Brown* (H); Shasta Co., *Baker & Nutting* (H); Sonoma Co., Santa Rosa Creek Canyon, 1936, *Goff* (H); Santa Cruz Mts., Black Mt., 1903, *Herre* (H); San Mateo Co., Butano Creek, 1901, *Dudley* (H); Humboldt Co., Lawrence Creek, 1926, *Tracey* (H); Pasadena, 1910, *Kingman* (F); Sonoma Co., Sonoma, 1891, *Bioletti* (F, NY); Sonoma Co., Cazadero, 1896, *Howe* (NY, C); Mt. Tamalpais, 1892, *Howe* (NY); Amador Co., Jackson, 1892, *Hensen* (NY); Searsville Redwoods, *Bolander* (US); Millard Canyon, Pasadena, 1909, *Kingman* (F); San Gabriel Mts., Los Flores Canyon, 1911, *Kingman* (F); Hetch Hetchi Valley, 1911, *Reed* (F); San Gabriel Mts., Sturdevant Trail, 1910, *Kingman* (F); Santa Cruz Mts., 1903, *Herre* (F); 1905, *Herre* (Minn); Searsville, 1864, *Bolander* (C, Y); Taylorville, 1892, *Howe* (C); Yosemite Valley, *Hasse* (NY); no locality or date, *Otto Lugar* (Minn). COLORADO: Rocky Mt. Nat'l. Park, Longs Peak Valley, 1936, *Kiener* (Mo, Mich). IDAHO: Priest River, 1915, *Weir* (F); 1914, *Weir* (DA, Mich); Coeur d'Alene, 1915, *Rust* (US). MAINE: Kingfield, 1923, *Norton* (F); Princeton, 1913, *Sanford* (F).

MINNESOTA: Warroad, 1901, *Fink* (US); Hudson River Trading Post, 1897, *Fink* (US). MONTANA: Glacier Nat'l. Park, Lake Terry, 1910, *Jones* (Mich); Lyman Canyon, Bozeman, 1925, *Young* (Mich). NEW HAMPSHIRE: Mt. Woodstock, 1899 (Cum. I, 359). OREGON: Mary's Peak, Corvallis, *Sipe* (Mich, DA); Eugene *Faxon* (Mich); Corvallis, *Sipe* (Mich); Portland, 1933, *Darrow* (Mich, F); Forest Grove, 1898, *Sweetser* (US, F, Mo); Union Co., Mill Creek, 1897, *Sheldon* (US); Eugene, 1930, *Sipe* (DA); Mt. Hood, 1930, *Sipe* (DA); no locality, 1885, *Henderson* (F); no locality, 1871, *Hall* (F); Cascade Locks. Columbia River, 1933, *Lawrence* (Wel); Cascade, Left Fork Wallowa River, Wallowa Co., 1897, *Sheldon*

(Wel); Clackamas Co., Clarkes, 1899, *Elmer* (H); Clatsop Co., Saddle Mt., 1936, *Browne* (H); Oregon Boundary, Cascades Mt. to Fort Coville, 49° N., 1860, *Lyall* (F); no locality, 1858, *Lyall* (F); no locality, *Sprague* (F); Willamette Hills, 1892, *Mulford* (NY, Mo); Yamhill Co., 1878, *Summers* (NY); Gopher Valley, McMinneville, 1880, *Summers* (P); Arthur, 1882, *Howell* (P); Eugene, 1883, *Collier* (P); Salem, *Hall* (C); no locality, *Calkins* (C). UTAH: no locality, 1869, *Watson* (US).

VERMONT: Newfane, Baileys Brook, 1935, *Evans* (Y). WASHINGTON: Mt. Constitution, 1907, *Cowles* (US); Langley, 1922, *Grant* (D); 1923, *Grant* (C); Seattle, 1910, *Bardell* (Mo); Seattle, 1891, *Parker* (Wel); Lake Ozette, 1939, *Smith* (C, F, Mich); Kalalock, 1939, *Smith* (C, Mich); Kalalock, 1934, *Smith*, (F); Olympic Rain Forest, 1940, *Butcher* (C); Baker Lake, 1941, *Mains* (Mich, F); Olympic Mts., Queets River Valley, 1907, *Frye* (Mich, F); Clearwater River, 1939, *Smith* (Mich); Grays Harbor Co., Montesano, 1898, *Heller* (Minn); Pullman, 1900, *Cotton* (F); Pullman, 1913, *Weaver* (F); Seguim, 1915, *Grant* (F); Washington Territory, 1865, *Torrey* (F); Westport, 1908, *Foster* (F); Pacific Beach, 1911, *Foster* (F); Mt. Rainier, 1909, *Foster* (F); Copalis Valley, 1909, *Foster* (F); King Co., Grass Mt. Trail, 1931, *Howard* (F); Dungeness, 1913, *Foster* (Wel); Hamilton, 1905, *Foster* (Wel); Chelan Co., Stehekin Valley, 1931, *Howard* (Wel); San Juan Co., San Juan Islands, Pt. Caution, 1928, *Howard* (Wel); Pacific Co., Loomis Lake, 1931, *Howard* (Wel); Kitsap Co., Mountaineers Cabin, 1940, *Eyerdam* (Mich); Marysville, 1927, *Grant* (DA); Gray's Harbor Co., Copalis Beach, 1948, *Eyerdam* (Wis); Red Mt., King Co., 1942, *Eyerdam* (Wis); Island Co., Whidby Co., 1948, *Eyerdam* (Wis).

12a. **Peltigera membranacea** f. **prolifera** Thomson, n. f.

Thallus isidiatus ad marginem et ad rimas, ceterum ut in species.

This regeneration form has small flat platelets along the borders and on the upper side of the thallus. The type is in the Farlow Herbarium of Harvard University.

BRITISH COLUMBIA: Mayne Island, 1914, *Macoun* no. 326.

REJECTED NAMES

Peltigera crenulata Vainio, Philippine Jour. Sci. Sect. C, 8: 113, 1913.

This species was described from the Philippines. A cotype in the herbarium of the New York Botanical Garden shows it to be either *P. polydactyla* f. *lophyra* or *P. horizontalis* f. *laciniata* but in the absence of apothecia it cannot be placed in either species.

Peltigera elisabethae Gyel. Bot. Koz. 24: 135, 1927.

This species was described without fruit. Two specimens determined as this species are in the herbarium of Yale University. Both they and the description show this species to be but *P. polydactyla* f. *microphylla* or *P. horizontalis* f. *zopfi* but in the absence of apothecia this name cannot be placed in the correct synonymy.

Peltigera polydactyla a. (var.) *major*. Kremphbr., Denks. d. k. Bayer Bot. Ges. IV, abth. 2: 126, 1861—nomen nudum.

Peltigera polydactyla var. *subspuria* Nyl. apud Cosson, Bull. Soc. Bot. France 15: 188, 1868—nomen nudum.

Peltigera rufescens f. *sorediifera* Nyl., Lich. Fueg. et Patagon. 5, 1887—nomen nudum.

Antilyssa horizontalis 24
Byrsalis 2
Chloropeltis 3
Dermatodea 16
Dermatodea canina 41
Emprostea 16
Lichen aphthosus 3
Lichen caninus 41
Lichen caninus var. *aphthosus* 3
Lichen caninus var. *cinereus* 41
Lichen caninus var. *pellucidus* 28
Lichen caninus var. *polydactylon* 28
Lichen caninus var. *rufescens* 47
Lichen collinus 16
Lichen horizontalis 24
Lichen horizontalis var. *nebulosus* 24
Lichen polydactylus (polydactylon) 28
Lichen rufescens 47
Lichen rufus 47
Lichen scutatus 16
Lichen scutatus * *Peltidea collina* 16
Lichen spurius 58
Lichen terrestris 41
Lichen venosus 13, 41
Lichen verrucifer 3
Lichen verrucosus 3
Peltidea 2, 3
Peltidea sect. *Emprostea* 16
Peltidea aphthosa 4
Peltidea aphthosa f. *complicata* 12
Peltidea aphthosa f. *crispa* 12
Peltidea aphthosa f. *variolosa* 7
Peltidea aphthosa var. *leucophlebia* 7
Peltidea aphthosa var. *variolosa* 7
Peltidea aphthosa var. *verrucosa* 4
Peltidea canina 41
Peltidea canina var. *albescens* 44
Peltidea canina var. *crispa* 47
Peltidea canina var. *glabra* 34
Peltidea canina var. *inflexa* 47
Peltidea canina var. *malacea* 37
Peltidea canina var. *membranacea* 62
Peltidea canina var. *rufescens* 47
Peltidea canina var. *spuria* 58
Peltidea collina 16
Peltidea erumpens 59
Peltidea glauca 29
Peltidea horizontalis 24
Peltidea horizontalis var. *collina* 17
Peltidea horizonalis var. *hymenina* 29
Peltidea horizontalis var. *lophyra* 34
Peltidea hymenina 29
Peltidea leucorrhiza 44
Peltidea malacea 37
Peltidea melacea f. *inflexa* 47
Peltidea pellucida 29
Peltidea polydactyla 28
Peltidea polydactyla var. *microcarpa* 34
Peltidea polydactyla var. *pellucida* 28
Peltidea polydactyla var. *spuria* 58
Peltidea rufescens 47
Peltidea rufescens var. *collina* 16
Peltidea scutata 16
Peltidea scutata var. *collina* 16
Peltidea spuria 58
Peltidea ulorrhiza 45
Peltidea ulorrhiza var. *praetextata* 55
Peltidea venosa 13
Peltidea verrucosa 4
Peltigera 2
Peltigera D. *Antilyssa* 2
Peltigera sect. Peltidea 3
Peltigera sect. *Eupeltigera* 16
Peltigera sect. *Peltigerina* 16
Peltigera subgen. *Peltigera* 16
Peltigera aloisii 47
Peltigera amplissima 3
Peltigera aphthosa 3
Peltigera aphthosa f. *angustiloba* 7
Peltigera aphthosa f. *complicata* 12
Peltigera aphthosa f. *crispa* 12
Peltigera aphthosa f. *minor* 7
Peltigera aphthosa f. *variolosa* 7
Peltigera aphthosa f. *verrucosa* 4
Peltigera aphthosa var. leucophlebia 7
Peltigera aphthosa var. *phymatodes* 4
Peltigera aphthosa var. typica 5
Peltigera aphthosa var. variolosa 7
Peltigera aphthosa var. variolosa f. complicata 12
Peltigera aphthosa var. variolosa f. crispa 12
Peltigera avenosa 39
Peltigera behringiana 58
Peltigera bouly de lesdainii 17
Peltigera canina 41
Peltigera canina f. *crispata* 47
Peltigera canina f. *cyatheum* 60
Peltigera canina f. *digitata* 41
Peltigera canina f. *leucorrhiza* 44
Peltigera canina f. *membranacea* 62
Peltigera canina f. *nitens* 23
Peltigera canina f. *palmata* 41
Peltigera canina f. *rufa* 47
Peltigera canina f. *sorediata* 59
Peltigera canina f. *sorediifera* 60
Peltigera canina f. *spongiosa* 56
Peltigera canina f. *spuria* 58
Peltigera canina f. *ulophylla* 47
Peltigera canina f. *ulorrhiza* 45
Peltigera canina f. *undulata* 55
Peltigera canina f. *vivipara* 55
Peltigera canina var. albescens 44
Peltigera canina var. *attenuata* 29
Peltigera canina var. *canina* 41
Peltigera canina var. *coriacea* f. *campestris* 45
Peltigera canina var. *coriacea* f. *genuina* 47
Peltigera canina var. *coriacea* f. *incusa* 47
Peltigera canina var. *coriacea* f. *polydactyla* 29
Peltigera canina var. *coriacea* f. *sorediata* 55
Peltigera canina var. *crispa* 47, 55

* Accepted names are in Roman type, synonyms are in italics.

Peltigera canina var. *crispata* 47
Peltigera canina var. *dolichorrhiza* 36
Peltigera canina var. *erumpens* 60
Peltigera canina var. *extenuata* 60
Peltigera canina var. *horizontalis* 24
Peltigera canina var. *inflexa* 47
Peltigera canina var. *leucorrhiza* 44
Peltigera canina var. *lepidophora* 40
Peltigera canina var. *Lichen rufescens* 47
Peltigera canina var. *limbata* 17, 55
Peltigera canina var. *malacea* 37
Peltigera canina var. *membranacea* 62
Peltigera canina var. *membranacea* f. *genuina* 44
Peltigera canina var. *membranacea* f. *leucorrhiza* 44
Peltigera canina var. *membranacea* f. *palmata* 41, 44
Peltigera canina var. *membranacea* f. *rufa* 47
Peltigera canina var. *membranacea* f. *sorediata* 55
Peltigera canina var. *membranacea* f. *spongiosa* 56
Peltigera canina var. *notata* 60
Peltigera canina var. *palmata* 41
Peltigera canina var. *polydactyla* 29
Peltigera canina var. *praetextata* 55
Peltigera canina var. *pusilla* 58
Peltigera canina var. rufescens 47
Peltigera canina var. rufescens f. innovans 55
Peltigera canina var. *scutata* 17
Peltigera canina var. *sorediifera* 59
Peltigera canina var. *soreumatica* 59
Peltigera canina var. spongiosa 56
Peltigera canina var. spuria 58
Peltigera canina var. spuria f. sorediata 55, 59
Peltigera canina var. *suomensis* 47
Peltigera canina var. ulorrhiza 45
Peltigera canina var. *ulorrhiza* f. *crispa* 47
Peltigera canina var. *undulata* 55
Peltigera canina var. *undulata* f. *spongiosa* 56
Peltigera canina var. *vulgaris* 41
Peltigera canina subvar. *spongiosa* 56
Peltigera canina subsp. *rufescens* 47
Peltigera canina subsp. *rufescens* subvar. *sorediata* 60
Peltigera canina subsp. *rufescens* subvar. *inflexa* 47
Peltigera canina subsp. *rufescens* var. *praetextata* 55
Peltigera canina subsp. *spongiosa* 56
Peltigera collina 16
Peltigera coloradoënsis 43, 47
Peltigera crenulata 65
Peltigera degeni 23
Peltigera degeni f. *tasmaniae* 23
Peltigera dolichorrhiza 36
Peltigera dolichorrhiza f. *javanica* 36
Peltigera elisabethae 65
Peltigera erumpens 42, 43, 60
Peltigera erumpens f. *densa* 60
Peltigera erumpens f. *glabrescens* 60
Peltigera erumpens f. *leptoderma* 60
Peltigera erumpens f. *scabrida* 60
Peltigera evansiana 20
Peltigera extenuata 60
Peltigera genuina 22
Peltigera genuina f. *palmatoides* 22
Peltigera genuina f. *minutella* 23
Peltigera hazslinszkyi 60
Peltigera horizontalis 24
Peltigera horizontalis f. lacinulata 28
Peltigera horizontalis f. *lobatoides* 24
Peltigera horizontalis f. *ticinensis* 28
Peltigera horizontalis var. *muscorum* 27
Peltigera horizontalis var. pruinosa 27
Peltigera horizontalis var. *sorediata* 17
Peltigera horizontalis var. ticinensis 28
Peltigera horizontalis var. typica 26
Peltigera horizontalis var. typica f. lacinulata 28
Peltigera horizontalis var. typica f. muscorum 27
Peltigera horizontalis var. typica f. zopfi 28
Peltigera hymenina 29
Peltigera lepidophora 40, 42, 43
Peltigera leptoderma 60
Peltigera leptoderma var. *brasiliensis* 60
Peltigera leucophlebia 7
Peltigera leucophlebia f. *variolosa* 7
Peltigera limbata 17
Peltigera magyarica 29
Peltigera malacea 37
Peltigera malacea f. *polyphylla* 39
Peltigera malacea f. prolifera 39
Peltigera malacea var. *crispa* 47
Peltigera malacea var. *dactylodes* 37
Peltigera malacea var. polyphylla 39
Peltigera malacea var. *ulophylla* 47
Peltigera mauritzii 17
Peltigera mauritzii var. *asiatica* 17
Peltigera mauritzii var. *dubiosa* 17
Peltigera membranacea 62
Peltigera membranacea f. *fibrilloides* 62
Peltigera membranacea f. *fibrillosa* 62
Peltigera membranacea f. prolifera 65
Peltigera membranacea f. *subfibrilloides* 62
Peltigera membranacea var. *szatalae* 62
Peltigera meridiana 36
Peltigera mexicana 43
Peltigera microphylla 33
Peltigera microphylla f. *lophyroides* 33
Peltigera molesta 17
Peltigera muscorum 27
Peltigera nana 36
Peltigrea nylanderi 17
Peltigera oceanica 36
Peltigera oceanica f. *luzoni* 36

Peltigera pellucida 29
Peltigera perfida 33
Peltigera perfida f. *lophyroides* 33
Peltigera plittii 43, 47
Peltigera plittii f. *ornata* 47
Peltigera plittii f. *suffusa* 41, 47
Peltigera plittii f. *subsuffusa* 47
Peltigera plittii var. *macrolobata* 41
Peltigera plittii var. *sandwicensis* 41
Peltigera polydactyla 28
Peltigera polydactyla f. *dactylifera* 35
Pelitgera polydactyla f. lophyra 34
Peltigera polydactyla f. microcarpa 34
Peligera polydactyla f. microphylla 33
Peltigera polydactyla f. *minor* 34
Peltigera polydactyla f. *pellucida* 29
Peltigera polydactyla f. *scutata* 17
Peltigera polydactyla f. *sorediata* 17
Peltigera polydactyla var. *collina* 17
Peltigera polydactyla var. crassoides 35
Peltigera polydactyla var. *dissecta* 34
Peltigera polydactyla var. dolichorrhiza 36
Peltigera polydactyla var. *hymenina* 35
Peltigera polydactyla var. *hymenina* f. *microcarpa* 34
Peltigera polydactyla var. *limbata* 17
Peltigera polydactyla var. *major* 65
Peltigera polydactyla var. *microcarpa* 34
Peltigera polydactyla var. *microcarpa* f. *cephalodigera* 34
Peltigera polydactyla var. *nervosa* 34
Peltigera polydactyla var. *obscurior* 17
Peltigera polydactyla var. *scutata* 17
Peltigera polydactyla var. *spuria* 58
Peltigera polydactyla var. *subnervosa* 34
Peltigera polydactyla var. *subspuria* 65
Peltigera polydactyla var. typica 30
Peltigera polydactyla var. typica f. lophyra 34
Peltigera polydactyla var. typica f. microphylla 33
Peltigera polydactyla var. typica f. microcarpa 34
Peltigera polydactyla var. *undulata* 55
Peltigera polydactyla var. *vulgaris* 29
Peltigera polydactyloides 35
Peltigera polydactyloides var. *guineensis* 35
Peltigera ponojensis 58
Peligera praetextata 55
Peltigera praetextata f. *lapponica* 55
Peltigera praetextata f. *subglabra* 55
Peltigera praetextata f. *vivipara* 55
Peltigera praetextata var. *inaequalis* 55
Peltigera praetextata var. *ilseana* 55
Peltigera praetextata var. *subglabra* 55
Peltigera propagulifera 17
Peltigera pulverulenta 23
Peltigera pusilla 58
Peltigera pusilla var. *vulnerata* 60
Peltigera rufescens 47, 58
Peltigera rufescens f. *albidula* 47
Peltigera rufescens f. *incusa* 47
Peltigera rufescens f. *inflexa* 47
Peltigera rufescens f. *innovans* 55
Peltigera rufescens f. *praetextata* 55
Peltigera rufescens f. *sorediata* 60
Peltigera rufescens f. *sorediifera* 65
Peltigera rufescens f. *spuria* 58
Peltigera rufescens var. *crispa* 47
Peltigera rufescens var. *horizontalis* 24
Peltigera rufescens var. *inflexa* 47
Peltigera rufescens var. *innovans* 55
Peltigera rufescens var. *pachyphylla* f. *crispa* 47
Peltigera rufescens var. *pachyphylla* f. *spuria* 58
Peltigera rufescens var. *palmata* 58
Peltigera rufescens var. *polydactyla* 29
Peltigera rufescens var. *praetextata* 55
Peltigera rufescens var. *spuria* 58
Peltigera rufescens var. *virescens* 23
Peltigera rufescens var. *vulnerata* 60
Peltigera scabrosa 22
Peltigera scabrosa f. regenerans 23
Peltigera scutata 16
Peltigera scutata f. *alba* 17
Peltigera scutata f. *nuda* 17
Peltigera scutata f. *septentrionalis* 17
Peltigera scutata var. *collina* 17
Peltigera scutata var. *genuina* 17
Peltigera scutata var. *limbata* 17
Peltigera scutata var. *propagulifera* 17
Peltigera scutata var. *squalida* 17
Peltigera scutata var. *subscabrosa* 17
Peltigera scutata var. *typica* 17
Peltigera sibirica 17
Peltigera sorediata 60
Peltigera spuria 42, 58
Peltigera spuria var. *erumpens* 60
Peltigera spuriella 58
Peltigera subscutata 17
Peltigera subscutata var. *spitzbergensis* 17
Peltigera scutata var. *subscutatoides* 17
Peltigera suomensis 43, 47
Peltigera szatalae 60
Peltigera tereziana 58
Peltigera ticinensis 28
Peltigera ulcerata 60
Peltigera vainioi 60
Peltigera variolosa 7
Peltigera variolosa f. *britannica* 7
Peltigera variolosa f. *complicata* 12
Peltigera variolosa f. *crispa* 12
Peltigera variolosa f. *dactylodes* 7
Peltigera variolosa f. *dilacereratella* 12
Peltigera variolosa var. *leucophlebia* 7
Peltigera venosa 13
Peltigera venosa var. *digitata* 58
Peltigera venosa var. *microcarpa* 14
Peltigera virescens 23
Peltigera zahlbruckneri 35
Peltigera zopfi 28
Peltophora 16
Phlebia (sect) 3

The Vegetation of Stock Pond Dams in Central Oklahoma

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The State of Oklahoma possessed 188 artificial lakes and 71,000 impounded stock ponds as of January 1, 1947 (Okla. Planning and Resources Board, 1947). Although construction of impoundments has slowed down somewhat, it is probable that the number of artificial water bodies increased by at least 10 per cent during 1947 and 1948. Ponds (here defined as any impoundage less than ten acres) have been constructed to provide water for domestic animals, to provide recreational areas, and to help in the control of erosion. Most of the dams were built by contractors hired by tenants or land owners, with financial aid from the U. S. Department of Agriculture. In these federal aid projects, it is required that the dams be planted with grass, and it is recommended that the ponds be fenced in order to exclude livestock and thereby to prevent erosion.

Revegetation of primary and secondary bare areas in Oklahoma has received some attention from investigators. Booth (1941) found that the succession in abandoned fields in central Oklahoma includeed weed, annual grass, perennial bunch grass and true prairie stages. Smith (1940) reported the following successional stages in Central Oklahoma: (1) Mixed weed, (2) *Aristida oligantha,* (3) *Aristida oligantha-A. basiramea,* (4) *Aristida-Eragrostis,* (5) subclimax, and (6) climax (*Andropogon scoparius-Bouteloua curtipendula*). He found no areas, however, that had been abandoned long enough for succession to have reached the climax prairie stage.

All of the dams studied are located within a radius of five miles from Norman, Oklahoma. The residual soil from which the pond dams were constructed is a clay loam, derived from Hennessey shale of the Permean redbeds. In the construction of most of these dams the topsoil was covered by several feet of red clay taken from the basin of the pond (Fig. 1). In the construction of a few dams, the top soil was pushed to one side and used later to cover the faces, tops, and backs of the dams. Although required by law, little or no grass was placed on some dams. On most planted dams, Bermuda grass* was used but in some cases, the native buffalo grass was employed. Very few of the ponds were surrounded by fences and none was seen with a watering trough below the fenced pond.

* The authors wish to acknowledge their indebtedness to Dr. Elwyn Hughes and Dr. Lawrence Rohrbaugh for critical reading of the manuscript.

* Common names are used throughout the text. See Table 1 for all scientific names, which are listed according to the International Rules of Nomenclature.

METHODS

The investigation on the vegetation of the dams was made in the autumn of 1947 and the spring of 1948. A total of fifteen dams were studied and eleven of these were investigated quantitatively. Permission to study the dams was secured from the landowners or tenants. A complete history of the dams was obtained whenever possible In order to standardize the information obtained about the various dams, a detailed questionnaire was prepared which was completed in the presence of the landowner or tenant. The dates of completion of the dams were checked with the Agricultural Conservation Program Office in Norman in all cases in which federal grants were provided.

Fig. 1.—A recently constructed dam (3 months old) showing sterile red clay and initial invaders.

After the reconnaissance trips were made, the vegetation in the following areas was studied in some detail: (1) back of the dam, (2) top and face of the dam down to the high water level, (3) face of the dam at the high water level, and (4) the beach—the area around the pond between the high and low water levels. Ten 0.5 square meter quadrats were used in each area. Although we have studied only ten quadrats in each area, it is felt that these data do give a reasonably accurate quantitative measure of the vegetation.

The cover and usually the number of individuals of each species noted in the quadrats were recorded, the cover being expressed in per cent of ground covered by each species in the quadrat. Percentage cover is perhaps the best criterion which can be used in determining the relative importance of various species found in an area. The abundance of a particular species (i.e., number per quadrat) is meaningless when it comes to determining dominance. In some

cases, one large plant of a certain species will occupy more space than numerous small plants of another species and, therefore, dominate the latter species in the competition for light, water, and soil nutrients. Furthermore, it is often difficult to determine just what constitutes a single plant, particularly in the cases of stoloniferous or rhizomatous grasses.

TABLE 1.—Earliest flowering dates of the important species on stock pond dams in Central Oklahoma.

Scientific name	Common name	First flowers
Ambrosia psilostachya DC	Western ragweed	Jul. 20
Amphiachyris dracunculoides DC (Nutt.)	Broomweed	Jul. 5
*Andropogon saccharoides Swartz	Silvery beard-grass	May 20
Artemisia ludoviciana Nutt.	Prairie sage	Jul. 20
*Buchloe dactyloides (Nutt.) Engelm.	Buffalo grass	Apr. 20
Carya illinoensis (Wang.) K. Koch	Pecan	May 25
Celtis laevigata Willd.	Hackberry	Apr. 5
Coreopsis tinctoria Nutt.	Golden tickseed	May 25
*Cynodon dactylon (L.) Pers.	Bermuda grass	May 25
*Digitaria sanguinalis L.	Crabgrass	Jul. 5
Erigeron canadensis L.	Horseweed	Jun. 25
Euphorbia marginata Pursh.	Snow-on-the-Mountain	Jul. 20
Helianthus annuus L.	Sunflower	Jun. 5
Melilotus alba Desr.	Sweet Clover	May 5
Populus deltoides Marsh.	Cottonwood	Mar. 20
Rhus glabra L.	Smooth sumac	May 5
Salix nigra Marsh.	Black willow	Apr. 15
Symphoricarpos orbiculatus Moench.	Buckbrush	Jun. 25
Tamarix gallica L.	Salt-cedar	Apr. 25
Ulmus americana L.	American elm	Mar. 1
Xanthium commune Britt.	Cocklebur	Aug. 15

* In grasses, initial appearance of inflorescence was taken as the beginning of flowering.

VEGETATION OF BEACHES

As the water recedes during the summer months, the exposed bare area is often invaded by numerous annual and first-year perennial plants. The most important plants noted on the beaches were golden tickseed, crabgrass, and cocklebur. No succession, however, occurs on the beaches since the terrestrial and wetland plants are destroyed by the filling of the pond in the spring and the aquatic plants are killed by desiccation following the annual lowering of the water level, by evaporation, during the late summer and autumn.

WILLOW ZONE

The first spring after the water is impounded a zone of black willows appears on the face of the dam at the maximum spring pool level. This zone often extends as a more or less continuous belt around the entire pond. It usually includes some cottonwoods and salt cedars. The development of the willow community is favored by the exclusion of grazing animals. Where well developed it shades out nearly all herbaceous species. Where heavily browsed, it is

replaced largely by the broomweed and western ragweed in the upper portion of the zone and by sedges and rushes near the springtime water level.

The vegetation of the beaches and of the area immediately above the spring pool level is not influenced by the absence or presence of planted material on the dams. On the other hand, the vegetation of the face of the dam above the spring pool level, and that of the tops and backs of the dam is conditioned largely by the amount of planting in these areas.

TABLE 2.—Important species on the stock pond dams (as based on spring samples). Figures refer to per cent areal cover; M, species of major importance on dams not sampled by quadrats; t, trace.

Species	Age of dam in years 2	4	6	8
Planted Dams				
Sunflower	7			
Bermuda grass	25	56	M	M
Sweet clover	52			
Broomweed	2	4		
Western ragweed	5	3		t
Unplanted Dams				
Broomweed	18	12	13	5
Western ragweed	8	8	5	t
Bermuda grass	11	4		
Snow-on-the-mountain	1	3	1	t
Silvery beard-grass	2		9	4
Buffalo grass	1	2	6	41

VEGETATION ON UNPLANTED DAMS

In general, pioneer native plants appear shortly after the dams are constructed, whenever proper soil moisture and other environmental conditions obtain (Fig. 1). During the first four years broomweed and western ragweed are predominant on unplanted dams although snow-on-the-mountain and Bermuda grass (possibly planted) are abundant on some of the dams (Table 2). With the passage of time, especially in heavily grazed areas, buffalo grass becomes the predominant species, although the broomweed and western ragweed continue as conspicuous elements. With moderate grazing, silvery beard-grass shares dominance with the buffalo grass but rarely becomes the dominant species except in ungrazed or slightly grazed pastures (Fig. 3). With moderate to heavy grazing, the ecesis of woody species is prevented and forest communities do not become established.

VEGETATION ON PLANTED DAMS

As heretofore indicated a few dams were planted with Bermuda grass, and an occasional one was planted with buffalo grass. Sometimes sweet clover was sown on the dams in addition to the grass species. In general, Bermuda grass is

the predominant species during the first four years on planted dams (Table 2, Fig. 2). The length of time that this stage persists depends primarily on the amount of grazing, since Bermuda grass is favored by moderate to heavy grazing.

Bermuda grass is either invaded by prairie species, such as silvery beard-grass or prairie sage or, on parts of the dam with higher soil moisture, by such woody species as American elm, hackberry, pecan, sumac, and buck-brush. Although silvery beard-grass would eventually be displaced by true prairie dominants, it is possible that the subclimax of silvery beard-grass would remain indefinitely unless grazing were completely eliminated.

Fig. 2.—A planted but unfenced dam at the end of the fourth growing season covered with bermuda grass and broomweed. The willow zone (normally just above bare area) has been eliminated by grazing.

FACTORS IN PLANT SUCCESSION

Grazing is undoubtedly the most important single factor affecting the type of vegetation on stock pond dams. Other factors, in approximate order of importance, include the kind and amount of planting, the relative fertility of the soil, and the type of exposure. Obviously the above statements refer only to the portion of the dam or basin above the influence of the water in the reservoir proper. It is possible also that the amount of rainfall and the evaporating power of the air might be of extreme importance if dams were to be constructed just prior to a series of dry or wet years.

PHENOLOGY

The total list of plants encountered in this investigation included 182 species belonging to 132 genera, in 45 families. The families including the greatest number as well as the predominant species were the grasses (40 species) and the composites (37 species). In our study of phenology, data were collected from the dams at semi-weekly intervals, and from the Bebb Herbarium of the University of Oklahoma on species which did not flower during the course of the investigation.

The majority (65 per cent) of the species on the dams began to flower during the prevernal and vernal periods (Feb. 15 to May 15). This included only a few of the predominant species such as American elm, black willow, and

Fig. 3.—A dam, with moderate, periodic grazing, near the beginning of the thirty-second growing season showing the silvery beard-grass community and the elm-hackberry-pecan association on the back of the dam.

buffalo grass (Table 1). The remainder (35 per cent) of the species started to flower during the estival period (May 16 to Sept. 1). This group includes such predominant species as Bermuda grass, broomweed, silvery beard-grass, western ragweed, prairie sage, sunflower, and snow-on-the-mountain (Table 1). Although none of the species initiated anthesis during the autumnal period, such species as broomweed and snow-on-the-mountain reached their maximum of flowering during this period. Several (20) species bloomed in the spring and again in the autumn. Included in this group are plants which ecize on the beaches after the water has receded and various short-day plants which develop after the September rains.

SUMMARY

1. The vegetation of stock pond dams in the vicinity of Norman, Oklahoma, differed considerably due to age of the dam, degree of grazing, amount of planting, relative soil fertility, and type of exposure.

2. A mixture of annuals and first-year perennials was found on the areas exposed by evaporation during the summer.

3. A willow zone, just above the maximum spring pool level, extended as a more or less continuous belt around ponds, especially in ungrazed or moderately grazed pastures.

4. On portions of the dam with favorable soil moisture a fragmentary elm-pecan community was encountered, especially in the absence of grazing.

5. On unplanted dams, a mixed weed stage (mostly broomweed and western ragweed) is usually replaced by a short grass stage (buffalo grass), which persists for a long time in heavily grazed pastures.

6. On dams with Bermuda grass, the Bermuda grass stage usually persists indefinitely in heavily grazed pastures but is replaced by silvery beard-grass or by woody species when protected from grazing.

7. No dams were encountered upon which the true prairie climax had been reached.

8. The plants encountered on these stock pond dams included 182 species belonging to 45 families. The grasses and the composites included the greatest number and the predominant herbaceous species.

9. A majority (65 per cent) of the species began to flower in the prevernal and vernal periods (Feb. 15 to May 15) and the remainder initiated flowering during the estival period (May 16 to Sept. 1).

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The Fishes of the Illinois River in Oklahoma and Arkansas*

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With the cooperation of the Army Engineers, Tulsa District and the Oklahoma Game and Fish Department, a qualitative preimpoundment survey of the fishes of the Illinois River, in Oklahoma, was undertaken by the writers and a crew of nine students from the Department of Zoology of the Oklahoma Agricultural and Mechanical College in August 1946. The construction of a dam at Tenkillers Ferry was in its initial phases at that time.

The expedition was greatly aided by the services of Dr. H. I. Featherly of the Oklahoma A. and M. College Botany Department, and Mr. Cecil Haight of the Army Engineers. The State Game and Fish Department through its Warden, Mr. Jeff Kendall, and its Superintendent of Fisheries, Mr. A. D. Aldrich, made available the services of Mr. Ed Jarrell, Superintendent of the State Fish Hatchery at Tahlequah, who gave much needed advice concerning the river while he was transporting our gear from station to station. The hearty cooperation of Colonel C. H. Chorpening and Mr. L. G. Duck of the Army Engineers is greatly appreciated. Drs. A. I. Ortenburger, A. P. Blair, W. F. Blair, and Mrs. F. A. Blair generously gave permission to use materials and data collected by them. The writers are indebted to Dr. Carl L. Hubbs of Scripps Institution of Oceanography for nomenclatural aid and to Drs. R. M. Bailey and Robert R. Miller of the University of Michigan Museum of Zoology for the identification of some specimens and for sending pertinent data from their Museum files.

Space scarcely permits the mention of many students and friends who have cooperated in procuring specimens for study.

Historical Statement

The first collections of Illinois River fishes were made by Dr. S. E. Meek during July and August 1891, in Arkansas near Prairie Grove, Ladds Mill, Clear Creek at Johnston and Jordan's Creek, and Barren Fork at Dutch Mill. Meek (1894) reported 31 species in his annotated list and 32 species in a table.

A Museum of Zoology, University of Oklahoma expedition, directed by Dr. A. I. Ortenburger in 1927, collected a total of 24 species (Hubbs and Ortenburger, 1929b) from the following localities: Illinois River, Adair County, 4 mi. northwest of Watts; Bouyer Branch, Adair County, 6 mi. northwest of Watts; Flint Creek, Delaware County, 8 mi. west of the State Line; and Barren Fork, Adair County, near Baron.

* Contribution from the Department of Zoology (No. 162) and the Research Foundation of the Oklahoma Agricultural and Mechanical College, Stillwater.

Apparently there are no other published lists of fishes from the river system but many collectors have preserved specimens which are placed in the following repositories and college collections: University of Michigan Museum of Zoology, University of Oklahoma Museum of Zoology, Oklahoma Agricultural and Mechanical College Museum of Zoology, and the Tulsa University Collections.

METHODS

The usual methods of collecting fishes were employed, using seines of various lengths and mesh and one additional tool in the form of a 3-foot bobbinet seine with an extra-heavy lead line. This net, made by Mrs. Leah Moore, proved to be a most useful collecting net since it could be maneuvered in so many different habitats and with greater speed. Trotlines, flyrods, and casting equipment were also used with fair success.

DESCRIPTION OF THE RIVER

The Illinois River is about 145 miles long and drains a total area of 1,620 square miles in eastern Oklahoma and western Arkansas. It rises near Hubard, Arkansas, and flows north for about 27 miles, then turns west for about 13 miles to cross the state line 5 miles south of Siloam Springs, Arkansas. From this point it continues west for about 16 river miles then turns to the south and continues a course south-southwest to its confluence with the Arkansas River southeast of Gore, Oklahoma. It is a clear and swift stream with an average gradient, from the state line to the mouth of Barren Fork, of about 4.5 feet per mile; and from Barren Fork to the mouth, of about 4.2 feet per mile (Anon. 1936). The bottom is predominately coarse chert gravel with the bed rock exposed in places. The water level was very low, during the period August 13 to 27, 1946, and in most places covered less than half of the river bed, which varied from about 100 to over 200 feet in width. A water depth of a few inches, on the riffles, to over 10 feet in pools, which varied from about 100 yards to over 1 mile in length was encountered. The banks varied from steep limestone or shale cliffs over 200 feet high to sloping or vertical gravel banks 5 to 20 feet high. A visibility depth of from 4 to 5 feet prevailed at all stations (Fig. 1) except at Station 1 where, by virtue of a heavy shower near the headwaters, a reading of about 1 foot was obtained.

The course of the upper part of the Illinois River in Oklahoma is on Chattanooga formation (shale and sandstone), Tyner and Burgen undifferentiated formation (shale, brown sandstone, calcareous cherty sandstone, and limestone), and Burgen sandstone in the great bend northeast of Tahlequah. From 2 miles southeast of Tuscania to Chronister the course of the river is on Boon formation (chert, chert limestone and limestone). From a short distance south of Chronister to the mouth numerous formations such as: the Pitkin Limestone (a shaley limestone grading into massive limestone), the Winslow formation (a shale, thin bedded sandstone, and shale with quartz conglomerate), the Morror formation (a limestone, shale and calcareous sandstone), and for the last 6 or 7 miles the McAlester shale and alluvium lie

exposed in the river bed. The exposure of these formations is due to faulting and subsequent erosion.

The principal tributaries of the Illinois River in Oklahoma are: Flint Creek with a drainage area of 121 square miles and Barren Fork, (to which Tyner Creek and Courthouse Creek are tributary), with a drainage area of 343 square miles and Caney Creek with a drainage area of 94 square miles (Anon. 1936). The clear, swift tributaries have the principal part of their courses on Boon chert.

The average temperature of the Illinois River from August 13 to 27,

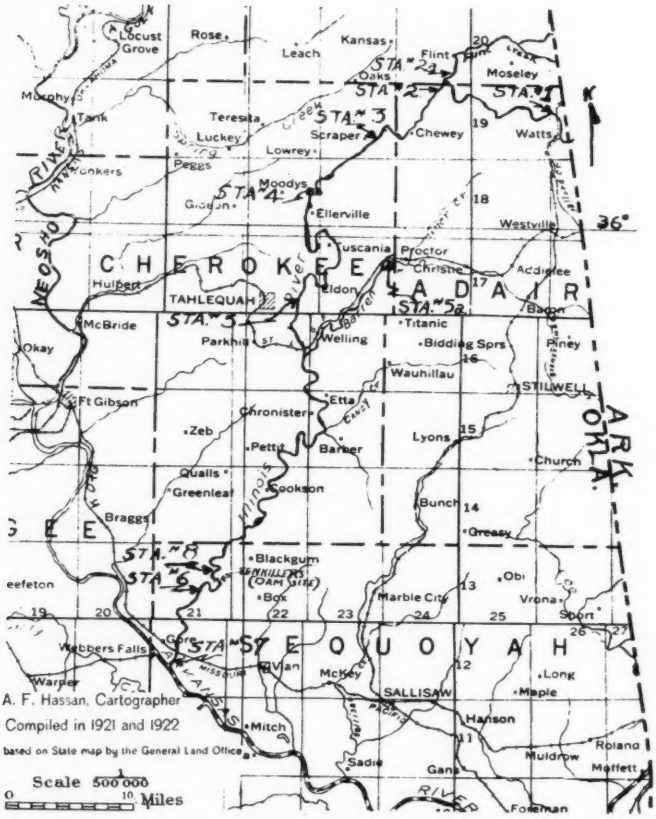

Fig. 1.—Map of the Illinois River in Oklahoma showing the collecting stations of the 1946 survey.

1946, was 29° (27°-32°) C. The pH was 7.6, except at Station 4 where a reading of 7.8 was obtained.

Very little emergent vegetation, except patches of *Dianthera americana* (in quiet water), was found in the river proper, although microscopic algae were abundant on the bottom. There are many small oxbow lakes and flood pools which often receive water by underground flow from the river. In these, various combinations of filamentous algae, *Chara, Elodea, Dianthera, Jussiaea, Echinodorous,* and *Sagitaria* were present. The forest flora of the Illinois Drainage is typical of the Oak Hickory Climax of the southwest Ozark Upland.

COLLECTING STATIONS (1946)

STATION 1.—Illinois River, Adair County, 1½ miles north of Watts, secs. 17 and 18, T. 19 N., R. 26 E.; August 13 and 14.

STATION 2.—Illinois River, Delaware County, near the mouth of Flint Creek, secs. 34 and 35, T. 20 N., R. 24 E. and secs. 2 and 3, T. 19 N., R. 24 E.; August 14 to 16.

STATION 2a.—Flint Creek, Delaware County, from the mouth on the Illinois River upstream for 1½ miles, secs. 26 and 35, T. 20 N., R. 24 E.; August 15. At this time Flint Creek flowed underground through coarse gravel for about the last 200 yards of its course, while upstream one half mile there was a good current below riffles. The bottom was gravel and rocks—in places bedrock covered with microscopic algae. The very clear stream (visibility about 4 feet) at this station was 20 to 75 feet wide and varied from a few inches to 5 feet in depth. The banks were rock cliffs often 50 feet high or sloping to vertical gravel banks from a few feet to over 10 feet in height.

STATION 3.—Illinois River, Cherokee County, near Scraper, secs. 25, 26, 27, and 34, T. 19 N., R. 23 E.; August 16 to 18. There were many cutoff and overflow pools in this area.

STATION 4.—Illinis River, Cherokee County, near Martin's Store east of Moody, secs. 13 and 24, T. 18 N., R. 22 E.; August 19 and 20.

STATION 5.—Illinois River, Cherokee County, east of Tahlequah, secs. 25, 26, and 35, T. 17 N., R. 22 E.; August 21 to 23. There were numerous cutoff and overflow pools in this area.

STATION 5a.—Barren Fork, Adair County, southwest of Proctor at and below the Bridge across Barren Fork on State Highway 51; August 22. In this area the Tyner formation is exposed in the stream's course. The bottom is composed of gravel and some rocks and along the south bank large boulders which had fallen from the steep rock cliff. The north bank was of sloping gravel. The stream at this station was from 30 to 75 feet wide and varied from a few inches to a little over 5 feet in depth. Objects were visible to a depth of about 5 feet in this swift stream where the only vegetation observed was microscopic algae.

STATION 5b.—Rea Sun Spring, a tributary of the Illinois River, about one half mile east of the Illinois River Bridge on U. S. Highway 62; August 22. Like most springs of the region this one forms a small brook with an abundance of water cress and other aquatic vegetation.

STATION 6.—Illinois River, Sequoyah County, about 5 miles northeast of Gore, secs. 22, 23, 27, and 28, T. 13 N., R. 21 E.; August 23 to 27. This station also served as a base camp for Stations 7 and 8.

STATION 7.—Illinois River, Sequoyah County, near the mouth of the river, secs. 20 and 21, T. 12 N., R. 21 E.; August 24.

STATION 8.—Illinois River, Sequoyah County, above the site of Tenkillers Dam, secs. 13 and 14, T. 13 N., R. 21 E.; August 25.

OTHER COLLECTIONS

In addition to the 1946 survey collections, we have examined specimens, or have received pertinent data from the Museums of the Universities of Oklahoma and Michigan, from various localities in the Illinois River System. The collectors, with dates and localities are given in chronological order. The symbols (O1, D1, etc.) are used in order to avoid long and frequent repetition of data in the annotated list.

ORTENBRUGER, A. I., July 1929

O1. Illinois River in Sequoyah County, 2 mi. east of Gore.
O2. Courthouse Creek (Barren Fork tributary) in Adair County, 9 mi. west of Westville.
O3. Tyner Creek (Barren Fork tributary) in Adair County, 13½ mi. southwest of Westville.
O4. Barren Fork (Illinois River tributary) in Adair County, near Baron.

TROWBRIDGE, ALBERT AND EDWARD STRODE, March 1932

TS1. Wards Branch (Illinois River tributary) in Adair County, 3 mi. northeast of Watts.
TS2. Flint Creek (Illinois River tributary), near Flint in Delaware County.
TS3. Ballard Creek (Illinois River tributary) in Adair County, 2 mi. northeast of Watts.

DOBSON, HUBERT, April 1936

D1. Illinois River in Adair County, 2 mi. northeast of Watts.
D2. Ballard Creek (Illinois River tributary) in Adair County, 2 mi. northeast of Watts.

BLAIR, W. F. AND F. A. BLAIR, July 1936

BB. Illinois River in Cherokee County, near Scraper.

MOORE, GEO. A. AND JOHN D. MIZELLE, April 1939

MM1. Barren Fork (Illinois River tributary) in Adair County, near Proctor.
MM2. Tyner Creek (Barren Fork tributary) in Adair County, ½ mi. east of Proctor.

MOORE, GEO. A., March 1941

M1. Illinois River and Swimmers Branch in Sequoyah County, 5 mi. northeast of Gore.

SEAMSTER, AARON, March 1941

S. Swimmers Branch (Illinois River tributary) in Sequoyah County, 5 mi. northeast of Gore.

MOORE, GEO. A., April 1942

M2. Illinois River and Peavine Branch in Cherokee County, 1 mi. south of Scraper.
M3. Swimmers Branch (Illinois River tributary) in Sequoyah County, 5 mi. northeast of Gore.

MOORE, GEO. A., May 1947

M4. Barren Fork (Illinois River tributary) near Heart-O-Hills Camp in Cherokee County, near Tahlequah.
M5. Ben Knight Creek (Barren Fork tributary) in Adair County, 3 mi. west of Westville.
M6. Caney Creek (Illinois River tributary) in Cherokee County, 2 mi. north of Barber.
M7. Flint Creek (Illinois River tributary) in Delaware County, near Flint.

BLAIR, ALBERT P., June 1948

AB1. Illinois River in Cherokee County, near Scraper.

BLAIR, ALBERT P., July 1948

AB2. McSpadden Creek (Illinois River tributary) 7 mi. north of Tahlequah. Note: This creek is not shown on map.

BLAIR, ALBERT P., August 1948

AB3. Caney Creek (Illinois River tributary) in Adair County, 2 mi. northwest of Stilwell.

AB4. Barren Fork (Illinois River tributary) on U. S. Highway 59 between Westville and Stilwell in Adair County.

AB5. Illinois River in Sequoyah County, near Gore.

The above collections from 1894 to 1948, exclusive of the 1946 survey, contain a total of 59 species and subspecies in 34 genera. The published lists of Meek (1894) and Hubbs and Ortenburger (1929b) contain a total of 42 forms. The present paper lists 92 forms including 3 species for which we have no specimens but fairly conclusive evidence of their occurrence in the river system. We feel that if thorough studies were conducted during other months of the year, the number of species assignable to the Illinois River would possibly exceed 100.

ANNOTATED LIST OF FISHES

Following the scientific name and common name of each species, literature references, 1946 collection stations, symbols of other collections, and pertinent notes are given in that order. Unless literature references are given each species is being reported as a first record for the Illinois River.

PETROMYZONIDAE

1. *Ichthyomyzon castaneus* Girard. Chestnut lamprey.—Station 4.

A single specimen, taken alive from the jaws of a water snake, is apparently the third record for Oklahoma. Meek (1894) reported it from Sallisaw Creek, near Makey's Store and Moore (1933) reported it as *Ichthyomyzon unicolor* from Spavinaw Lake.

2. *Ichthyomyzon gagei* Hubbs and Trautman. Southern brook lamprey.—Moore (1933) as *Reighardina unicolor* Creaser and Hubbs. Bailey (1947).

POLYODONTIDAE

3. *Polyodon spathula* (Walbaum). Paddlefish.—The paddlefish undoubtedly occurs in the river although no specimens were taken by our party. A mounted head was seen at Watts and said to have come from Station 1. Burt Tarkinton, a commercial fisherman at Tahlequah, presented us with a paddle and asserted that 148 paddlefish were taken during the winter (1945-1946). Sportsmen also attested to the presence of paddlefish in the Illinois. Mr. Purdy of Tahlequah insisted that there are two species of paddlefish in the river, a statement given some credence by Dr. Carl L. Hubbs (personal communication) who wrote that Dr. S. F. Hildebrand has some evidence to support this view.

LEPISOSTEIDAE

4. *Lepisosteus osseus oxyurus* Rafinesque. Northern longnose gar.—Stations 1, 2, 3, and 4.

A 616 mm. specimen contained 4 *Notropis* and 1 *Lepomis cyanellus* in its stomach.

HIODONTIDAE

5. *Amphiodon alosoides* Rafinesque. Goldeye.—Paden (1948); Moore (1947). Station 4.

This, the first specimen (250 mm.) reported to be actually taken in Oklahoma, was caught on a helgramite-baited hook by a fisherman and is the same specimen reported by Paden and by Moore. Many other specimens have since been taken in both the Red and Arkansas Rivers. The species is especially common in Lake Texoma.

CLUPEIDAE

6. *Pomolobus chrysochloris* Rafinesque. Skipjack.—Stations 2, 3, 4, 5, and 7.

The first skipjack to be taken in Oklahoma was that of C. L. Hubbs and M. B. Trautman from an overflow pool on the Grand (Neosho) River in September 1935 (basis for its inclusion by Hubbs, in Aldrich, 1946). The presence of many young indicates that *Pomolobus* is a spring or early summer breeder in the Illinois River.

7. *Dorosoma cepedianum* (LeSueur). Gizzard shad.—Hubbs and Ortenburger (1929b). Stations 1, 2, 3, 5, 6, and 7. AB1, BB, and O1.

Although well distributed in the river, shad are not abundant.

SALMONIDAE

8. *Salmo gairdnerii* Richardson. Rainbow trout.—Trout are not indigenous in the Illinois, but a private hatchery located 3 miles west of Westville on Ben Knight Creek, a Barren Fork tributary in Adair County, is owned by Dr. Gibson, a Tahlequah dentist. A single young specimen was taken below the hatchery in May, 1947.

CATOSTOMIDAE

9. *Megastomatobus cyprinella* (Valenciennes).—Largemouth buffalofish.—Stations 5 and 6.

Our two specimens confirm the statement (Hubbs and Lagler, 1941) that it is "typically an inhabitant of large rivers, oxbows, and bayous" since they were taken in large overflow pools comparable to oxbows.

10. *Ictiobus niger* (Rafinesque). Black buffalofish.—Stations 2 and 6.

Four adult specimens were taken. The species is undoubtedly more abundant than is here indicated since it is frequently taken by gigging parties. One hundred eighty-three young specimens assigned by Dr. R. M. Bailey to *Ictiobus* were taken at Station 7.

11. *Ictiobus bubalus* (Rafinesque). Smallmouth buffalofish.—Station 6.

This (a single specimen) and the foregoing species were taken with *Moxostoma duquesnii* in a 50 ft. 1 inch-mesh seine at a depth of about 5 ft.

12. *Carpiodes carpio carpio* (Rafinesque). Northern carpsucker.—Station 6.

Our single adult specimen quite probably indicates that this species occasionally wanders into the Illinois from its muddy home, the Arkansas River.

13.* *Carpiodes velifer* (Rafinesque). Highfin sucker.—Stations 5 and 6.

Four specimens are assigned to this species with considerable hesitation. Comparison was made with a single specimen identified by C. L. Hubbs and M. B. Trautman and reported by Moore and Mizelle (1939) from Stillwater Creek in Payne County. The Illinois specimens are too slender and the anterior dorsal rays are too short but the eye is large and the nostrils are placed over or in front of the tip of the lower jaw, which bears a pointed protuberance.

14. *Catostomus commersonnii commersonnii* (Lacépède). Common white sucker.—Meek (1893 and 1894) as *Catostomus teres* (Mitchill); Hubbs and Ortenburger (1929b). M6.

The common white sucker is certainly rare in Oklahoma but is now known from Spavinaw Creek and Little Spring Creek, tributaries of Grand (Neosho) River, in addition to the above records. Meek found this species common in the Illinois River at Prairie Grove and Ladd's Mill.

15. *Hypentelium nigricans* (LeSueur). Hog sucker.—Meek (1893 and 1894) as *Catostomus nigricans* (LeSueur). Stations 1, 2, 3, 4, 5, 6, and 8. M3, M7, MM2, and O1.

This species was taken primarily in riffles and fast water.

16. *Minytrema melanops* (Rafinesque). Spotted sucker.—Station 3. BB.

Our single specimen was taken in a slough.

17. *Moxostoma duquesnii duquesnii* (LeSueur). Black redhorse.—Meek (1894) as *M. duquesnei* (sic); Hubbs and Ortenburger (1929b). Stations 1, 2, 3, 4, 5, 6, and 7. BB, M2, MM2, and O1.

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* Troutman (May 24, 1950) reexamined the Stillwater Creek specimen and called it *carpio*. We prefer to refer to item 13 as *carpio*.

Residents of the area take redhorses by means of the gig and gang hooks and regard them as superior to black bass in flavor.

18. *Moxostoma erythrurum* (Rafinesque). Golden redhorse.—Hubbs and Ortenburger (1929b). Stations 1, 2, 3, 4, 5, 6, and 7. AB1, BB, M3, MM2, and O1.

19. *Moxostoma aureolum* (LeSueur). Northern redhorse.—Station 2.

Moore and Cross (1950) have recently reported this for Oklahoma but failed to include the Station 2 specimen (280 mm.) which is quite similar to the examples from the Chikaskia River and Grand Lake. Mr. Milton Trautman is studying the species and will report on its taxonomic status.

20. *Placopharynx carinatus* Cope. River redhorse.—Stations 1, 2, 4, and 5.

First reported for Oklahoma by Jordan and Gilbert (1886) from the Poteau River, this species had since eluded all collectors, in Oklahoma, until our party secured 8 specimens (Paden, 1948).

CYPRINIDAE

21. *Cyprinus carpio* Linnaeus. Carp.—Stations 3, 4, and 6.

Carp were taken in small numbers by means of gigs, trotlines, and seines.

22. *Semotilus atromaculatus atromaculatus* (Mitchill). Northern creek chub.—Meek (1893 and 1894); Hubbs and Ortenburger (1929b). Stations 1, 2, 2a, 3, 4, and 5. AB2, AB3, M5, M6, M7, MM2, O1, and O3.

This species is quite scarce in the river proper but was frequently taken in springs and small tributaries.

23. *Nocomis biguttatus* (Kirtland). Hornyhead chub.—Meek (1893 and 1894) as *Hybopsis kentuckiensis* (Rafinesque); Hubbs and Ortenburger (1929b). Stations 1, 2, 2a, 3, 4, 5, 6, and 8. AB3, BB, M6, M7, MM1, MM2, O3, O4, and S.

This abundant species was usually taken in fast water, although some young were found in shallow quiet water.

24. *Hybopsis storerianus* (Kirtland). Silver chub. Station 7.

The 2 specimens undoubtedly had wandered into the river from the Arkansas, the muddy waters of which is a preferred habitat.

25. *Hybopsis amblops amblops* (Rafinesque). Northern bigeyed chub.—Meek (1893 and 1894). Stations 1, 2, 3, 4, 5a, 6, and 8. AB1, BB, M6, M7, MM2, O3, and O4.

This species appears to prefer the quiet water below riffles.

26. *Erimystax dissimilis* (Kirtland). Spotted chub. All Stations. BB and O1.

The name *Erimystax dissimilis* is not properly applied to this species which will be named as new by Dr. C. L. Hubbs and Walter Crowe in the near future. Specimens were most frequently taken from under flat rocks in shallow, fast water at the head of riffles. When disturbed, *Erimystax* was observed to dart swiftly away to hide under the rocks. The retreat chosen was often too small to accommodate the entire body, but as soon as the head was hidden the fish became motionless. This crepuscular habit explains the usual absence of the species in ordinary seine hauls.

27. *Extrarius aestivalis tetranemus* (Gilbert). Arkansas River speckled dace.—Station 7. AB5.

The 7 species taken near the mouth of the river, like several other species herein reported, are surely wanderers from the muddy Arkansas River.

28. *Chrosomus erythrogaster* Rafinesque. Southern redbelly dace.—Hubbs and Ortenburger (1929b). Station 2a. AB3, D2, M2, M5, M6, MM2, and O4.

All specimens taken by our party were from a cool spring with an abundance of emergent vegetation (*Radicula, Jussiaea,* and *Dianthera*) and some filamentous algae.

29. *Notemigonus crysoleucas auratus* Rafinesque. Western golden shiner.—Stations 3, 5, and 7. M3 and S.

At station 7 this species was taken from the river proper but the other specimens were found in overflow pools. Ortenburger and Hubbs (1926) and Hubbs and Ortenburger (1929a and b) listed *N. c. crysoleucas* for Oklahoma, however, Hubbs (in Aldrich 1946) listed *N. c. auratus* and *N. c. ceco* (sic.). Hubbs, (personal communication) has indicated that Oklahoma golden shiners are referable to *auratus* except possibly in the southeast where *seco* may be found. Material from McCurtain County is available and will be treated in a subsequent paper. The specimens herein reported have an average of 12.9 anal rays, in agreement with Schultz (1926) who reported that count for the Arkansas River System in Oklahoma.

30. *Notropis atherinoides atherinoides* Rafinesque. Emerald shiner.—Stations 4 and 7. O1.

This species appears to be rather rare in Oklahoma and was recently (Moore 1948) erroneously reported for the Mountain Fork River. The form therein concerned is *Notropis fumeus fumeus* Evermann.

31. *Notropis percobromus* (Cope). Plains shiner.—Station 7. O3.

This is not *N. percobromus* of Hubbs and Ortenburger (1929b), but is the species so frequently referred to *N. atherinoides* (Hubbs 1945). This species frequents the Arkansas River and its silty tributaries on the plains and has been reported as far west as Coldwater Creek, 8 miles southeast of Guymon, Oklahoma (Hubbs and Ortenburger 1929a and b).

N. percobromus is rather easily confused with *N. atherinoides* and, although Hubbs (1945) pointed out several differences, the two are not readily separated on the basis of single character which overlap considerably in Oklahoma specimens. Very little overlap is found in stepping the head length into standard length. In spite of these difficulties the two forms have a very different appearance. An analysis of characters is being compiled for Oklahoma material by Frank B. Cross and will appear later.

32. *Notropis rubellus* (Agassiz). Rosyface shiner.—Meek (1893 and 1894) as *Notropis dilectus* (Girard); Hubbs and Ortenburger (1929b) as *Notropis percobromus* (Cope). All stations. AB1, AB2, BB, M2, M4, M6, MM2, O1, O3, O4, and TS2.

This is the species bearing the *nomen nudum, Notropis rubricorpus* (Hubbs in Aldrich 1946) and provisionally referred to *N. percobromus* (Hubbs and Ortenburger, 1929b), according to Hubbs (personal communication) and Hubbs (1945). *Notropis rubellus* is one of the most abundant fishes of the Illinois River, being found in all habitats but showing a distinct preference for fast water along with *N. z. pilsbryi.*

33. *Notropis fumeus* Evermann. Ribbon shiner.—Station 5.

This is not *Notropis fumeus fumeus,* which is an abundant species in tributaries of the Red River, but an undescribed form recognized by Dr. Carl L. Hubbs. Three specimens (26-27 mm. in standard length) are catalogued as No. 2770 in the Oklahoma Agricultural and Mechanical College Museum of Zoology. They were taken from a backwater pool over a bottom of gravel and mud.

34. *Notropis umbratilis umbratilis* (Girard). Southern redfin shiner.—Stations 1 and 7. O1 and S.

This species, an inhabitant of more sluggish streams in both the Red and Arkansas River Systems, finds a suitable habitat in quiet backwaters, sloughs, and overflow pools.

35. *Notropis cornutus chrysocephalus* (Rafinesque). Central common shiner.—Meek (1893) as *Notropis megalops* Jordan and Gilbert, and (1894) as *Notropis cornutus* (Mitchill); Hubbs and Ortenburger (1929b). Stations 1 and 4.

This species must, at present, be considered rare in the Illinois River, although Meek reported it abundant in the river at Prairie Grove, Arkansas. It may still be abundant in the headwaters since farther north *chrysocephalus* is abundant in small streams. *Notropis cornutus isolepis* of the Red River System is more abundant in the larger clear tributaries.

Meek (1893) reported *Notropis megalops* and omitted *Notropis cornutus* but in 1894 reversed the two. His remarks, p. 245, indicate that the latter species was correctly assigned to the river.

36. *Notropis zonatus pilsbryi* Fowler. Arkansas striped shiner.—Meek (1893 and 1894); Hubbs and Moore (1940); Hubbs and Ortenburger (1929b). All stations. AB1, AB2, AB3, AB4, BB, M2, M4, M6, M7, MM1, MM2, O1, O2, O3, and O4.

This is one of the most abundant minnows in the Illinois River. Although it prefers fast water, 2 to 4 feet deep, in 1946 it seemed that population pressure was so great that striped shiners were present in all habitats, even muddy overflow pools.

37. *Notropis blennius* (Girard). River shiner.—Station 7. O1.

This is another species that wanders into the Illinois from the Arkansas River in which it is widely distributed (Hubbs and Lagler 1941).

38. *Notropis greenei* Hubbs and Ortenburger. Wedgespot shiner.—Meek (1893) according to Hubbs and Ortenburger (1929b) confused this species with *N. boops*. Stations 1, 2, 2a, 3, 4, 5, 6, 7, and 8. AB1, BB, O1, and S.

The wedgespot shiner prefers swift deep channels where spawning was in progress on August 15. Ripe females extruded eggs into the hand when specimens were picked up from the seine. The presence of breeding individuals and young in graded sizes indicates a long breeding period. This attractive minnow is probably a very important bass forage fish since both the spotted bass and smallmouth frequent the same habitat. On one occasion a wedgespot shiner leaped out of the water as it was pursued by a bass. The minnow, under observation by Moore, was instantly killed when it landed on a gravel bar.

39. *Notropis spilopterus* (Cope). Spotfin shiner.—Stations 1, 3, 6, 7, and 8. BB, M1, M6, and S.

The only listing of this fish for Oklahoma is that of Hubbs (in Aldrich 1946) based on specimens collected from the Illinois River in March 1941 by Moore. A specimen collected by W. F. and F. A. Blair in July 1936, and originally identified as *N. whipplii*, was later referred to *spilopterus* by R. M. Bailey.

N. spilopterus was taken from rather deep fast water below riffles in association with *N. camurus*, *N. z. pilsbryi*, *Campostoma*, and *Micropterus*. Young specimens (under 35 mm.) of *camurus* and *spilopterus* are extremely difficult to separate. The writers found no characters which could be used successfully.

40. *Notropis camurus* (Jordan and Meek). Bluntface shiner.—Stations 1, 2, 3, 4, 5, 6, 7, and 8. AB1, BB, and O1.

The only literature reference to this species in Oklahoma is that of Hubbs (in Aldrich 1946).

41. *Notropis lutrensis lutrensis* (Baird and Girard). Red shiner.—Stations 1, 4, 5, 6, 7, and 8. BB, M6, and O1.

42. *Notropis boops* Gilbert. Bigeye shiner.—Meek (1893) as *N. boops*, and (1894) as *Notropis shumardi* (Gilbert); Hubbs and Ortenburger (1929b). Stations 1, 2, 3, 4, 5, 6, 7, and 8. AB1, AB4, BB, M1, M6, MM1, MM2, O1, O4, and S.

This very abundant minnow was found in practically all types of habitat. It is believed that Meek's record of *Notropis heterdon* for the Illinois is possibly referable to *N. boops*.

43. *Notropis volucellus* (subspecies).—Stations 5, 6, and 8. O1.

Hubbs and Gordon (MS) have recognized this as a new subspecies which awaits description.

44. *Notropis volucellus buchanani* Meek. Ghost mimic shiner.—Station 7.

This form found only near the river's mouth is sharply segregated ecologically from the preceding subspecies which occupies a niche in the clear main channels in contrast to

the more sluggish waters inhabited by *buchanani*. The two forms are readily recognized as distinctly different.

45. *Phenacobius mirabilis* (Girard). Suckermouth minnow.—Station 7.

This widely distributed species is nowhere abundant in Oklahoma, but can be expected in sandy streams of considerable gradient.

46. *Dionda nubila* (Forbes). Ozark minnow. Meek (1893 and 1894) as *Hybognathus nubila* (Forbes); Hubbs and Ortenburger (1929b). All stations. AB1, AB2, AB4, BB, M1, M2, M3, M4, M5, M6, M7, MM1, MM2, O1, O2, O3, O4, S, and TS2.

On the basis of specimens taken by the survey party in all habitats, this species is the most abundant fish in the river.

47. *Hybognathus nuchalis* Agassiz. Silver minnow.—Meek (1893) listed this species but omitted it later (1894).

We list it here despite Meek's later omission, because we feel that it properly belongs in the river's fauna.

48. *Hybognathus placita placita* Girard. Plains minnow.—Meek (1893) reported *H. nuchalis placita*, but later (1894) omitted this species. Station 7.

Our 5 specimens are surely wanderers from the silty waters of the nearby Arkansas.

49. *Pimephales promelas confertus* (Girard). Southern fathead minnow.—Meek (1894). Station 7.

It is interesting that in 1894 Meek found this fish "common" at Prairie Grove and yet no other collection of this species have been made in the upper portions of the river. Our 3 specimens probably wandered into the Illinois from the Arkansas.

50. *Ceratichthys perspicuus* (Girard). Bullhead minnow.—Station 7. O3.

Our observations are in agreement with those of Hubbs and Black (1947) who state: "The preferred habitat of *C. perspicuus* appears to be the sluggish muddy backwater and bayous of the large and medium-sized streams." This and the following form are readily separated by means of characters given in Table IV, p. 19, of Hubbs and Black (1947).

51. *Ceratichthys tenellus tenellus* (Girard). Neosho mountain minnow.—Hubbs and Black (1947). Stations 4, 5, 5a, 6, 7, and 8. O1.

52. *Hyborhynchus notatus* (Rafinesque). Bluntnose minnow.—Meek (1893 and 1894) as *Pimephales notatus;* Hubbs and Ortenburger (1929b). Stations 1, 2, 3, 4, 5, 5a, 6, and 7. AB1, BB, M1, M6, MM2, O1, S, and TS2.

The bluntnose minnow is common in the quiet backwaters and small oxbow lakes.

53. *Campostoma anomalum pullum* (Agassiz). Central stoneroller.—Meek (1894); Hubbs and Ortenburger (1929b). All stations. AB1, AB2, AB3, AB4, BB, M1, M2, M3, M4, M5, M6, M7, MM2, O1, O2, O3, O4, TS2, and TS3.

Although *Campostoma* spawns in culture ponds (Langlois 1937) these activities are confined to the shallow riffles in tributaries of the Illinois River. In May, 1947, large numbers of adult males were congregated on riffles in Caney Creek where they were vigorously and literally rooting in the gravel with their caudal fins breaking the surface of the water. Collections made with a screen from the redd yielded some eggs presumed to be of this species. No evidence of nest building has been observed in Oklahoma. This observation is somewhat unlike that reported by Hankinson (1919) who stated that only one or two males worked at a "pit." In Caney Creek no pits were observed but literally hundreds of males were so closely packed on the riffles that it seemed there was no room for more. The vigorous working of the fish in the shallow water prevented observation of the presence of females. However, the occurrence of non-adhesive eggs on the riffle would seem to point to these activities as a breeding behavior. Hankinson stated that they vigorously give chase to one another, but we noticed no such encounters, in fact, each fish seemed to be oblivious of the presence of others.

No morphological difference between northern and Ozarkian *Campostoma* is known but there does seem to be some evidence of physiological difference.

AMEIURIDAE

54. *Ictalurus lacustris punctatus* (Rafinesque). Southern channel catfish.—Stations 1, 2, 3, 4, 5, 6, 7, and 8.

In spite of the wide distribution of this species in the Illinois River, no previous collectors took specimens. Except for young-of-the-year, taken from under flat stones at the head of riffles, all of our specimens were taken in water over 6 feet deep by means of sport-fishing tackle.

55. *Ameiurus melas catulus* (Girard). Southern black bullhead.—Meek (1894) as *A. melas*. Stations 2, 3, and 5. M1 and O1.

This species was found only in cutoff pools and oxbows.

56. *Ameiurus natalis natalis* (LeSueur). Northern yellow bullhead.—Hubbs and Ortenburger (1929b). Stations 1, 2, 2a, 3, 4, 5, 5a, and 6. M1 and MM2.

The yellow bullhead occupies much the same habitat as the preceding form.

57. *Pilodictis olivaris* (Rafinesque). Flathead catfish.—Stations 2 and 6.

This species apparently prefers to lie in deeper water among boulders, submerged tree trunks, and holes under overhanging banks and thus eludes the scientific collector. *Pilodictis* was associated with the young of *Noturus* and *Erimystax* under flat rocks at the head of a riffle. One specimen was taken on a trotline.

58. *Noturus flavus* Rafinesque. Stonecat.—Meek (1893) reported this species for the Illinois River and Barren Fork, but in a later publication (1894) apparently covering the earlier collections, the species was omitted. Stations 2, 2a, 3, 5, 6, 7, and 8.

The stonecat seems to prefer rather large flat stones although one was found beneath a paper pie plate.

59. *Schilbeodes mollis* (Hermann). Tadpole madtom.—Meek (1894) reported *Noturus gyrinus* (= *mollis*) in his table (p. 92), but omitted the species from his list (p. 86).

Since we now know *mollis* from several localities in Oklahoma (Moore and Cross, 1950) it is quite possible that Meek did take it in the Illinois River in Arkansas although no collector has found it in the river since that date.

60. *Schilbeodes nocturnus* (Jordan and Gilbert). Freckled madtom.—Stations 6, 7, and 8.

This small catfish was taken from shallow riffles in association with *S. insignis*.

61. *Schilbeodes insignis* (Richardson). Slender madtom.—Meek (1894) as *Noturus exilis* Nelson. All stations. AB2, BB, M2, M4, M6, M7, MM1, and MM2.

The slender madtom is probably more abundant than all other ameiurids combined, single collections often containing from 13 to 40 specimens. During the day the slender madtom lives in the interstices of the gravel but were frequently seen at night in large numbers on shoals in water 2 to 6 inches deep. Five to 10 individuals were counted in a circle of light about 18 inches in diameter. Their reaction to light was a mad rush for cover in the gravel. Our sport-fishermen declared that this species was the best live bait for *Micropterus*.

62. *Schilbeodes miurus* (Jordan). Brindled madtom.—Station 6. M1.

Although quite abundant in the Poteau River, *miurus* is apparently rare in the Illinois where its favored habitat on leafy muddy bottoms is not so extensive.

63. *Schilbeodes eleutherus* (Jordan). Furious madtom.—Station 7. AB3.

This form was first reported for Oklahoma by Jordan and Gilbert (1886) who took

it in the Poteau River at Slate Ford. Our four specimens from Station 7 are deposited as follows: 2 (No. 156772) in the Museum of Zoology, University of Michigan, and 2 (No. 2564) in the Museum of Zoology, Oklahoma Agricultural and Mechanical College. The species is not known to be abundant anywhere in Oklahoma.

ANGUILLIDAE

64. *Anguilla bostoniensis* (LeSueur). American eel.—Station 7.

A single dead and mutilated specimen. The eel, often caught on trot lines, is usually discarded by fishermen who dislike their snail-like appearance.

CYPRINODONTIDAE

65. *Fundulus notatus* (Rafinesque). Blackbanded topminnow.—Meek (1893 and 1894) as *Zygonectes notatus* (Rafinesque); Hubbs and Ortenburger (1929b). Stations 2, 3, 4, 5, 6, and 7. AB1, BB, M3, and MM2.

F. notatus and *F. olivaceus* occupy the same habitat (overflow pools, oxbow lakes, and to some extent backwaters) without any apparent interbreeding. A special effort was made to collect pairs in order to determine their characters. Both sexes of each pair proved to be either one or the other of the two forms, thus, in some measure, confirming their specific identity (see Table 1). The gradation in size of the young and the presence of gravid females of the two species at various stations indicate an extensive spring and summer spawning period.

TABLE 1.—Comparison of *Fundulus notatus* and *Fundulus olivaceus* by Dr. Carl L. Hubbs, based on specimens taken together in the Illinois River in Oklahoma by Moore (April, 1941).

	Fundulus notatus	*Fundulus olivaceus*
General body form	Deeper, particularly in males	More attenuate
Muzzle	More bluntly rounded in side view	More depressed
Mouth	More nearly transverse	With larger gape particularly in premaxillary region
Eye	Larger	Smaller
Eye in snout	About 1.2 in small adults to about 1.4 in large ones	About 1.5 in small adults, about 1.7 in large ones
Fins	Larger, especially in male (in high males D. and A. sharply pointed behind and reaching C.)	Smaller, more rounded, D. and A. less produced in males
Lateral band	Less intense, less even-edged; generally broader	More intense, more even-edged; generally narrower
Cross Bars	Lacking to moderately developed in females; strong in males	Lacking in females, usually weak in males
Sexual dimorphism	Greater	Less
Predorsal stripe	Rather strong, though often dashed, in young; remnant of spots usually retained in adult	Very weak and diffuse in young, lacking in adult
Postanal stripe	Rather strong and continuous in young; weak in adult	A row of dusky blotches in young; lacking in adult
Spots on body	More diffuse and irregular, brownish; less striking on darker ground color	More discrete—smaller, rounder, blacker; more bold on the light background
Black pigment about anal fin and anus young	Less developed (area narrower, less solid)	Well developed (area broad, more solid)

66. *Fundulus olivaceus* (Storer). Blackspotted topminnow.—All stations. AB1, BB, M2, M3, M6, MM1, and MM2.

The only other listing of this species for Oklahoma is that of Hubbs (in Aldrich, 1946). Long confused with *F. notatus* (see Table 1), *F. olivaceus* is the more abundant of the two forms in the Illinois River.

POECILIIDAE

67. *Gambusia affinis affinis* (Baird and Girard). Mosquitofish.—Stations 1, 2, 2a, 3, 4, 5, 6, 7, and 8. AB1, AB2, M3, and M5.

Gambusia was common wherever there was quiet water.

PERCIDAE

68. *Stizostedion canadense* (Smith). Sauger.—Although no sauger specimens were taken on this expedition, frequent reference of fishermen to "jack salmon" in the Illinois leaves little doubt of its presence. On May 25, 1947, a head and skin of *S. canadense* from Spring Creek, a tributary of the Grand River and similar in character to the Illinois River, was presented to us by Mr. Bud Jackson.

69. *Hadropterus phoxocephalus* (Nelson). Slenderhead darter.—Stations 1, 6, 7, and 8.

The presence of *phoxocephalus* in the Illinois River was a complete surprise since our past experience with the species is associated with sandy streams (Chikaskia River and Red Rock Creek) west of the Grand River. A preliminary study of the species in Oklahoma and Kansas indicates that the Illinois River population may prove to be intermediate in some respects between *phoxocephalus* of the Chikaskia and *H. nasutus* Bailey of the Poteau River. Further study is contemplated.

70. *Percina caprodes carbonaria* (Baird and Girard). Southwestern logperch.—Meek (1893 and 1894) as *Etheostoma caprodes* Rafinesque. Stations 1, 2, 2a, 3, 4, 6, and 8. D1.

The logperch is apparently not restricted in its habitat, since specimens were taken in swift water and in small cutoff pools. It was often associated with *Etheostoma* under flat stones in Flint Creek and at the head of riffles in the river proper.

71. *Doration saxatile* (Hay). Speckled darter.—Meek (1894) as *Etheostoma saxatile* Hay. Stations 1, 2, 3, 4, and 5. AB1, BB, and MM1.

Doration is associated with *Poecilichthys flabellaris* and *Schilbeodes insignis* in the shallow riffles over fairly fine gravel.

Dr. Carl L. Hubbs (personal communication) informs us that this is not *saxatile* but a new undescribed form.

72. *Poecilichthys zonalis arcansanus* Jordan and Gilbert. Arkansas banded darter.—Meek (1893 and 1894) as *Etheostoma zonale* (Cope). All stations. AB1, BB, M4, M5, M6, M7, MM1, and MM2.

Apparently there is a great fluctuation in abundance, from year to year, of this species in the Illinois River. In August 1946, nearly every seine haul contained *zonalis*, but Dr. A. P. Blair found it scarce in 1948. Furthermore, it could not have been abundant in 1927 since Hubbs and Ortenburger (1929b) did not report it. Riffle habitat seems to be preferred, but in 1946 population pressure was so high that it was present in practically all habitats.

73. *Poecilichthys spectabilis* Agassiz. Orangethroat darter.—Meek (1893 and 1894) as *Etheostoma coeruleum spectabile;* Hubbs and Ortenburger (1929b) as intergrades, *Poecilichthys coeruleus* (Storer); *pulchellus* (Girard) × *spectabilis* (Agassiz). All stations. AB1, AB2, AB4, BB, M1, M5, M6, M7, MM1, MM2, and O3.

This species was most abundant in shallow riffles of weak current, springs, and along gently sloping banks in moderate current. Our specimens range from very young through

adults in all stages of sexual development. The spawning period must surely be extended from early spring through the summer months.

74. *Poecilichthys punctulatus* Agassiz. Stippled darter.—Stations 3, 4, 5, and 6. AB1, BB, M5, M6, MM2, and S.

This relatively rare form was taken principally in heavily vegetated springs with slight gradient and in small leaf-filled indentations along the shore. We believe *punctulatus* is an early spring or winter breeder, however, one spent adult male with bright red belly was taken.

75. *Poecilichthys whipplii whipplii* (Girard). Western redfin darter.—Hubbs and Black (1941). Stations 6, 7, and 8. M3 and S.

The record of Hubbs and Black is from the headwaters in Arkansas but we took no specimens in the upper portions of the river. In the lower, more sandy 15 miles of river bed it seems to, in part, replace *P. zonalis*.

76. *Poecilichthys flabellaris lineolatus* (Agassiz). Striped fantail darter.—Meek (1894) as *Etheostoma flabellare* Rafinesque. Stations 1, 2, 3, 4, and 5. AB2, M6, M7, MM1, and MM2.

The absence of this darter in the lower portions of the river is directly attributable to its definite choice of shallow riffles with deep gravel bed in which the species hides.

77. *Etheostoma blennioides* Rafinesque. Greenside darter.—Meek (1893 and 1894). Stations 1, 2, 2a, 3, 4, 5, 5a, and 6. AB1, BB, M1, and M5.

This is the species reported by Hubbs (in Aldrich, 1946) as *Etheostoma blennioides newmani* (Agassiz), but recently Hubbs (personal communication) has informed us that it is a new and undescribed species. It is commonly an associate of *Noturus* and *Percina* under large stones at the head of riffles, in the main river, and in Flint Creek under flat stones in the main channel in moderately swift water 1 to 2 feet deep.

CENTRARCHIDAE

78. *Micropterus punctulatus punctulatus* (Rafinesque). Northern spotted bass.—Hubbs and Ortenburger (1929b). All stations. BB, M3, M4, and O1.

This is the most abundant game fish in the river. Hubbs and Bailey (1940) reported a specimen 17½ inches in length, but the largest of about 200 fish, taken while sport fishing, was 11¼ inches in standard length. The larger fish were found in swift channels below riffles and the young were taken in all habitats, even muddy overflow pools.

79. *Micropterus dolomieu velox* Hubbs and Bailey. Neosho smallmouth bass.—Meek (1893 and 1894); Hubbs and Ortenburger (1929b). Stations 1, 2, 2a, 3, 4, 5, 5a, 6, and 7. AB1, AB4, BB, M2, M3, M6, MM1, O1, O2, and O4.

The above distributional notes indicate that the smallmouth bass enter all noteworthy tributaries of the river, showing a preference for the upper, swifter, and cooler waters.

80. *Micropterus salmoides salmoides* (Lacépède). Northern largemouth bass.—Meek (1893 and 1894). Stations 1, 2, 2a, 3, 4, 5, 5a, 6, and 7. AB1, AB3, M3, M6, and S.

We follow Bailey and Hubbs (1949) in applying the trinomial to this form which was taken from backwaters, oxbows, and sloughs. It is possible that the largemouth bass reported by Meek were a complex of *salmoides* and *punctulatus* or entirely the latter since the differences between these forms were not fully appreciated until they were discussed by Hubbs (1927).

81. *Chaenobryttus coronarius* (Bartram). Warmouth.—Stations 2, 3, 5, and 6. AB1 and M2.

The warmouth is an uncommon species in the Illinois. Our 19 specimens were taken in backwaters, overflow pools, and oxbows.

82. *Lepomis cyanellus* Rafinesque. Green sunfish.—Meek (1893 and 1894); Hubbs

and Ortenburger (1929b) as *Apomotis cyanellus*. Stations 1, 2, 2a, 3, 4, 5, 5a, 6, and 7. AB1, BB, D1, M1, M3, M5, M6, MM1, and MM2.

83. *Lepomis humilis* (Girard). Orangespotted sunfish.—Hubbs and Ortenburger (1929b) as *Allotis humilis* (Baird and Girard). Stations 1, 3, 5, 6, and 7. AB1 and BB.

This species is represented by only 13 specimens in our collections from overflow pools, backwaters, and oxbow lakes. Since it is more common in muddier waters, we feel that the Illinois specimens represent a small population of wanderers from the Arkansas.

84. *Lepomis megalotis* (Rafinesque). Longear sunfish.—Meek (1893 and 1894); Hubbs and Ortenburger (1929b). All stations. AB1, AB3, AB4, BB, M2, M3, M4, M6, MM1, MM2, O1, O3, O4, and TS2.

This very common form is apparently not *L. m. breviceps* (Baird and Girard); it is easily differentiated from *megalotis* of the Red River System. The subspecies are being studied by Dr. Reeve M. Bailey of the University of Michigan and Dr. John D. Black of Northeastern Missouri State Teachers College.

85. *Lepomis macrochirus macrochirus* Rafinesque. Bluegill.—Meek (1894); Hubbs and Ortenburger (1929b) as *Helioperca incisor* (Cuvier and Valenciennes). Stations 1, 2, 2a, 3, 4, 5, 5a, 6, and 7. AB1, AB3, BB, M3, and M6.

The bluegill, though abundant, is not as common as *megalotis* in the Illinois drainage where it frequents quiet waters.

86. *Lepomis microlophus* (Günther). Redear sunfish.—Station 5. AB3 and M1.

Moore first found this species in Oklahoma near the mouth of Swimmers Branch in March 1941, and 13 specimens were secured by our party at Station 5. The species was introduced in Oklahoma from Texas and is being planted extensively in ponds and lakes where it exceeds the bluegill in size and popularity in most localities.

87. *Ambloplites rupestris rupestris* (Rafinesque). Northern rock bass.—Stations 1, 2, 2a, 3, 4, 5, and 5a. BB, M3, M6, MM2, and S.

Rock bass are scarce in the Illinois River and our party took only 33, all young-of-the-year. It was suually taken in quiet water in brush shelters in which a mass of leaves and trash had accumulated.

88. *Pomoxis annularis* Rafinesque. White crappie.—Stations 1, 3, 5, 6, and 7. BB.

Our specimens were taken from overflow pools and oxbow lakes. According to Mr. Ed Jarrell this species and the next have been planted in the river, but have not succeeded.

89. *Pomoxis nigro-maculatus* (LeSueur). Black crappie.—Stations 5 and 7.

Only two specimens.

ATHERINIDAE

90. *Labidesthes sicculus* (Cope). Brook silversides.—Meek (1893 and 1894); Hubbs and Ortenburger (1929b). Stations 1, 2, 3, 4, 5, 6, 7, and 8. AB1, AB3, AB4, and BB.

Labidesthes was usually common in quiet water where it was associated with *Gambusia* and *Fundulus*.

SCIAENIDAE

91. *Aplodinotus grunniens* Rafinesque. Drum.—Stations 2, 3, and 7.

Fishermen report that drum are fairly common.

COTTIDAE

92. *Cottus carolinae* (Gill). Banded muddler.—Meek (1894) as *Cottus bairdi* (Girard); Hubbs and Ortenburger (1929b) as *Cottus bairdii zopherus* (Jordan). Stations 1, 2, 2a, 3, 4, 5, and 5a. AB3, AB4, M4, M6, M7, MM2, O2, TS1, and TS2.

In assigning the Oklahoma muddlers to *C. carolinae*, we are following Bailey and Dimick (1949) and Dr. R. M. Bailey (personal communication). The species was particularly abundant under stones and among aquatic vegetation in springs. The stomach con-

tents of three specimens (75-95 mm.) from Flint Creek were examined and found to contain one 43 mm. *Etheostoma,* 12 helgramites (1½-2½ inches long), and a small crayfish cheliped.

HYBRID COMBINATIONS

1. *Lepomis macrochirus* × *Lepomis microlophus.*—Station 2 (1, 70 mm.).

This specimen has the body coloration more like *microlophus* but a somewhat diffuse dusky spot appears on the posterior dorsal rays as in *macrochirus;* scales 6-40-14; 19 rows of scales around the caudal peduncle; cheek scales in four rows; eye 4 in head; head 2.9 in standard length; depth 2.2; D. X, 12; A III, 11; the pectoral fin, when bent upward reaches the dorsal origin; and a few of the pharyngeal teeth have flattened tips—the pharyngeal bone is of intermediate width.

2. *Notropis rubellus* × *Notropis zonatus pilsbryi.*—Station 6 (1, 29 mm.).

The identification of this specimen was confirmed by Dr. R. M. Bailey. It resembles *pilsbryi* in having 2 lateral bands which are not as intense as in that form. The anterior portion of the lateral line is not conspicuously outlined with melanophores, a conspicuous character of *Notropis rubellus,* and the origin of the dorsal fin is almost over the anterior end of the pelvic base. It resembles *Notropis rubellus,* in having a sharper pointed head; dorsal streak slightly more intense; and body slender, but slightly deeper. The eye is intermediate between the two parent forms. Teeth 4-4, with pronounced hooks and a rather long grinding surface—the third from the bottom serrated. The anal fin has 9 principal rays.

3. *Dionda nubila* × *Notropis zonatus pilsbryi.*—Station 1 (1, 52 mm.); Station 3 (3, 28 to 39 mm.); Station 5 (5, 27 to 32 mm.); Station 6 (1, 44 mm.); Station 5a (18, 23 to 50 mm.). S.

The Swimmers Branch specimen was determined by Moore and confirmed by Dr. Hubbs. These specimens have two lateral bands, oblique mouth, intestines longer, and eye smaller than *pilsbryi* but larger than *Dionda.* The dorsal streak is intermediate and the teeth usually 4-4.

This is by far the most common hybrid combination of the Illinois River. During the spring of 1947 some observations made by Moore seem to indicate a possible explanation of the high incidence of hybridization. His notes follow:

> "May 3, 1947, was one of those beautiful balmy spring days (air temperature 22°C., water 20°C.) with a perfectly clear sky and no wind. As we approached a long stretch of riffle, shortly after midday, a considerable area of water appeared to reflect a beautiful crimson. Approaching closer, to about 20 feet, a most unusual sight greeted our eyes. An area of about 10 by 6 feet in gently flowing water about 1 or 1½ inches deep was occupied by thousands of male *zonatus* lying so close to each other that it seemed there was no room for more. They were so beautiful that the eye at first failed to detect the occasional less brilliant female, and surely there were not very many lying between the males. Their activities made the surface of the water quite rough and so the whole process of spawning escaped us. The males were rolling from side to side so that their brilliant crimson underparts made the water appear to be on fire. When we stepped into the riffle the minnows scattered. By means of a screen we were able to collect eggs, presumed to be of this species, from the redd.
>
> "Below the riffles occupied by *Notropis zonatus* was a deeper area (about 2 to 2½ feet) from which our seines took a considerable number of *Dionda* in breeding color. No evidence of the spawning of the ozark minnow was obtained but it seems quite possible that spermatozoa of *Notropis zonatus* could be carried by the current into the spawning area of *Dionda nubila* where they might fertilize the eggs of that species."

4. Unidentified hybrid.—Station 4.

One 33 mm. specimen of a hybrid, doubtless a cross between *Notropis zonatus plisbryi* and some other species, was taken from the Illinois River. The description of this speci-

men follows: body comparatively elongate; head rather pointed; mouth oblique; lower jaw almost equal to upper jaw which is 3.4 in head; lips pigmented; depressed dorsal 1.5 from origin to occiput; origin of dorsal slightly back of middle of body and behind the anterior end of pelvic fins. Dorsal stripe not interrupted by dorsal fin; not as wide as *pilsbryi;* single lateral band less intense than in *pilsbryi;* ventral surface below lateral band with few melanophores except for the two on each side of anal fin; peritoneum black; intestine short with two loops; eye 3 in head; snout 4 in head; depth 5.1; D. 7; A. 7; pelvics 8-8; C. 19 (principal rays); scales 5-33-3 and teeth 2, 4-4, 2 crowded and with hooks and rather long narrow ginding surfaces. This specimen has thus far defied identification.

DISCUSSION

The Illinois River is probably one of the richest rivers in the United States in regard to number of fish species. This faunal richness is due to its fortunate location midway between the Gulf and the Great Lakes, its constant supply of ozarkian spring water containing many representatives of that very characteristic fish fauna of the Ozark Uplands, and also representatives of the plains fauna have ready access from the Arkansas River. There is probably also a considerable influence of the larger Grand River (fish fauna little known but undoubtedly rich) which also drains a portion of the Ozark Uplift as well as a large area of plains country.

The influence of the North is evident in the presence of such species as *Amphiodon alosoides, Catosomus commersonii, Moxostoma aureolum, Hybopsis amblops, Notropis rubellus, Notropis spilopterus, Notropis cornutus chrysocephalus, Schilbeodes mollis,* and *Stizostedion canadense.*

Representatives of the plains fauna, *Carpiodes carpio, Hybopsis storerianus, Notropis percobromus, Notropis blennius, Notropis lutrensis, Notropis v. buchanani, Hybognathus p. placita, Pimephales p. confertus, Ameiurus m. catulus, Hadropterus phoxocephalus,* and *Lepomis humilis,* enter the lower portion of the Illinois River from the muddy Arkansas. Some of these species penetrate far upstream and others are apparently restricted to the more sandy lower portions.

The construction of the dam at Tenkillers Ferry poses some problems in the management of the fishery resources of the River and the impoundment. In the past the policy has been to stock impoundments heavily with game species as soon as possible and, although present policies are changing, to continue restocking thereafter. In view of the very rich fish fauna already present, the writers believe that the stocking of more game fishes, of indigenous species, would be a ridiculous waste of money and effort in spite of what may appear to be present in the youthful years of the lake. In all probability, a good population of game fishes will be present in the lake when it is completed, and if for no other reason than for purposes of experiment it would seem wise to leave the stocking of the lake to nature.

There is every possibility that channel catfish (*Ictalurus*), black bass (*Micropterus*), rock bass (*Ambloplites*), sauger (*Stizostedion*), crappie (*Pomoxis*), warmouth (*Chaenobryttus*), and a number of other less desirable food fishes can build up strong populations in a relatively short time. The natural fecundity of fishes is so great that a few pairs would doubtless produce more offspring at no cost than the hatcheries can produce at high

cost. It is believed that the planting, especially of fingerlings, will serve no useful purpose because of the large numbers of predatory fishes already present.

It is not at all likely that there will be a shortage of forage fishes since a good number of species already adapted to a lake habitat will be present. Among these are: the gizzard shad (*Dorosoma*), buffalofish (*Megastomatobus* and *Ictiobus*), carp (*Cyprinus*), several minnows (*Notemigonus, Notropis, Ceratichthys, Hyborhynchus,* and *Pimephales*). Another important fish is the brook silversides (*Labidesthes*) which is common in the river. Also for aesthetic reasons there are Oklahomans who would like to see the number of man-made changes, in perhaps our most beautiful river, kept to a minimum.

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Biological and Economic Notes on the Sharks of the Gulf of Mexico, With Especial Reference to Those of Texas, and With a Key for their Identification

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The elasmobranch fauna of Texas is little known. Jordan and Gilbert (1883) recorded 3 species from about Galveston. Evermann and Kendall (1894) added two more. Reed (1941) lists 24 from these waters, but gives no data. This paucity of information is unfortunate, for Texas presents, in her sharks, an interesting commingling of Panamanian, West Indian and South American forms. It will be noted that some of these have not been recorded from the United States until recently, and that they are recorded, even now, only from Texas. It seems not improbable that this is the northern limit of their range, and that the muddy waters of the Louisiana littoral form an effective barrier against any eastward spread along the coast.

As no comprehensive work has hitherto been attempted on these fishes in this section, an effort has been made to present all data possible for the use of those interested. Wherever possible a photograph or line drawing of the species has been used. In addition, a key has been prepared to aid the student in identifying the various species and all available information on range, food, breeding habits, embryology and economic uses has been incorporated, in order to present as complete a picture of each as is possible. The descriptions and notes on size and color are those used in *Guide to Commercial Shark Fishing in the Caribbean* (Anon. 1945).

ACKNOWLEDGEMENT

We are indebted in the preparation of these notes to Dr. William C. Schroeder; to Mr. Loren P. Woods; to Dr. S. F. Hildebrand; and to Dr. Gordon Gunter. To these gentlemen, and to all the others who aided in the preliminary work on this paper, go our sincerest thanks.

GINGLYMOSTOMA CIRRATUM (Bonnaterre)—Nurse shark, cat shark, gata

Range.—Found throughout the tropical Atlantic, being common in the West Indies and off the western coast of Africa. Reported from many localities from southern Brazil to southern Florida, in summer it ranges northward

both to the northern shores of the Gulf of Mexico and to North Carolina. Occasionally it is found as far north as New Jersey. In Pacific waters, it is found from the Gulf of California to Ecuador. This is the "Nurse," of which Dampier (1699) speaks, saying that in the Bay of Campeachy they saw "Sharks, Swordfishes, and *Nurses*. . . . The Nurse is just like a shark, only its skin is rougher." Today, in the same territory, nurse sharks are still found. The Mexican Servicio de Pesca lists them from the waters off the Territory of Quintana Roo, and from the coasts of Yucatan, Campeche, Tabasco, Vera Cruz, and Tamaulipas.

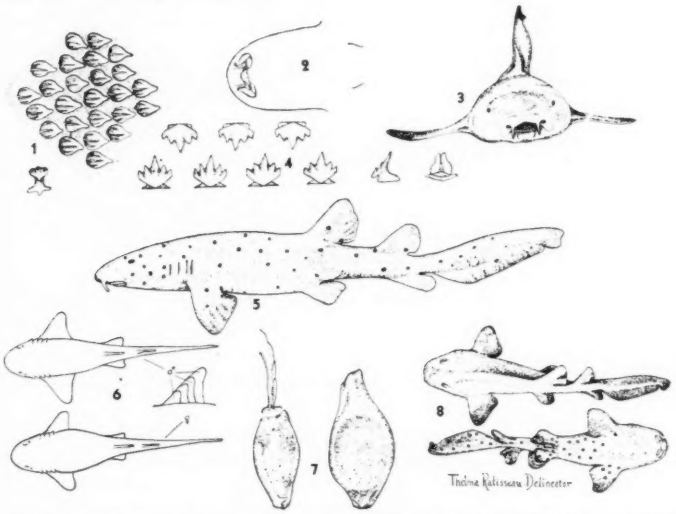

Plate 1. Figs. 1-8. *Ginglymostoma cirratum*.—1. Denticles (after Radcliffe); 2. Ventral view of head (after Garman); 3. Head-on view (after Nichols); 4. Teeth from near the front end of the jaw (after Garman); 5. *Ginglymostoma cirratum* (after Garman); 6. Male and female nurse sharks to illustrate sexual dimorphism. Comparison of pectoral fin outlines. From left to right, male, female, male, male (after Breder); 7. Fertile and wind eggs. The wind egg shows the rudiments of tendrils at the hinder end (after Gudger); 8. Young nurse sharks. The lower of the two is placed on its back to show markings and conformation of the under surface. In a still earlier stage numerous spots are also found upon the upper surface (after Nichols).

Occurrences in Texas.—This shark has been reported by the fishermen around Port Aransas, and one of us has seen a five-foot specimen taken near there in a shrimp trawl.

Color.—Yellowish or grayish brown above; a paler shade of the same hue below. Small ones are variously marked with small dark spots and cross-bars, but adults often lose these markings.

Size.—No greater than one foot in length at birth, nurse sharks mature at

5 feet or even less, often growing, however, to 11 or 12 feet. An 8½ foot specimen will weigh 330 to 370 pounds.

Description.—Trunk moderately stout; snout broadly rounded and noticeably short. The nasal barbel (the most distinctive feature) reaches back as far as the mouth; eyes very small; gill openings noticeably short, the fourth and fifth very close together over the origin of the pectoral; mouth transverse and nearly straight with very prominent labial furrows at the corners on both jaws; teeth 15 to 18 on each side of upper jaw and 14 to 16 each side below, similar in the two jaws, with high triangular central cusp, flanked on either side by 1 to 3 smaller ones; the first dorsal is over the pelvics, the second dorsal is nearly as large as the first and similar to it in shape; lower rear margin of the caudal is nearly straight; the anal a little smaller than the second dorsal; the pectoral broad and short with nearly straight distal edge and with rounded corners.

Habits and Food.—Found chiefly inshore and often in water only 2 or 3 feet deep, as in channels among mangrove keys, and on sand flats, bars, etc. It is sluggish and easily approached. Invertebrates, squid, shrimp, *Palinurus*, short-spined sea urchins, and *algae* (Gudger, 1921), have been found in the stomachs of Atlantic specimens, while a Pacific example (Beebe and Tee Van, 1941) contained five small fish and two carideans.

Breeding.—The breeding habits of this fish have been extensively studied by Gudger (1912a, 1921, 1940) and it is from his papers that the following account is given:

"Nurse sharks came into very shallow water to mate and pairs, so engaged, are often seen.

"External signs of the breeding season may be shown by the tattered hinder edges of the pectoral of the females. This is due to the fact that the male, prior to copulation, grasps the posterior edge of one or the other of these fins in his mouth. Due to his smallness and the inferiority of his dental armature, the female not infrequently breaks away, tearing and scarring the edges of her fins in the escape. Once, however, that a secure hold is attained, she is flipped over on her back and the male then inserts his claspers in the lateral pockets of her cloaca, and the seminal fluid is transferred."

Nurse sharks are ovoviviparous, and both oviducts are functional, but only one ovary, the right, is utilized. This becomes greatly enlarged, and is generally found in a median position, while the left ovary is small, insignificant, and in all Gudger's specimens contained no eggs.

The eggs pass from the ovary into the oviducts, and thence into the shell glands, where they acquire a hard, chitinous covering. From the shell glands the ova, as large as small oranges, pass into the posterior portion of the oviducts, which are enlarged immediately behind the shell glands to form paired uteri. In each of these from 15 to 20 eggs are retained until the young are hatched, and there the embryos remain until their development has reached its maximum.

Economic Uses.—This is the best of all American sharks for the production of leather, and the only one on which a premium is paid for the hide. The fins are not used, but the flesh is better than average, being white in color and suitable for use, either salted, filleted, or fresh. The vitamin content of the liver oil is generally low, ranging up to 6000 U. S. P. units per gram. This shark is eaten in the West Indies (Fowler, 1915), and on the Brazilian coast.

MUSTELUS CANIS (Mitchill)—Dog shark, dogfish, smooth dog

Range.—Normally this dogfish is abundant as far north as Cape Cod, and has been recorded as a stray in the Bay of Fundy (Hildebrand and Schroeder, 1928). From there it ranges south to Brazil and Uruguay. The species also occurs in South Africa (Fowler, 1941), and seems to be fairly common off the coast of Natal (Biden, 1934) and in the Mediterranean.

This shark is known in Cuban waters, around Jamaica, and at Trinidad, and is to be expected throughout the West Indian-Caribbean section. Very little is known about its occurrence there. By contrast it is one of the commonest sharks along the coast of the United States from North Carolina to southern New England, where it is a regular migrant north in spring, southward again in autumn. Present indications also are that there is but little interchange between the northern and southern populations, for it does not seem to occur at all along the east coast of Florida (Anon., 1945).

Occurrence in Texas.—Reed (1941) lists this species from Texas, giving no locality. A female, containing embryos, taken by Baughman on March 24, 1940, off Freeport, Texas, was identified by Mr. Springer as belonging to this species, and one of the embryos (U. S. N. M. 116,443) was deposited in the National Museum.

Oddly enough, this shark, which is little known in Texas, appears to be plentiful in Louisiana. Fowler (1933) states that it is common in the Calcasieu River in summer as far inland as Prien Lake.

Color.—Plain olive-slaty or brownish gray above, with the margins of the fins paler; yellowish or grayish white below.

Size.—Born at a length of 14 to 15 inches, it matures at three feet or less, occasionally to above five feet.

Description.—Trunk slender; snout moderately long and blunt-tipped; eye rather large; gill openings noticeably short, a little longer than the horizontal diameter of the eye; the teeth (the most distinctive feature of the genus) low, with bluntly rounded apex directed a little toward the corners of the mouth, similar in the two jaws, but a little more numerous in the lower (about 80) than in the upper (about 75), in mosaic arrangement, several series being in service simultaneously; mid-point of the base of the first dorsal about as near to the axil (armpit) of the pectoral as to the origin of the pelvics; second dorsal 2/3 to 4/5 as high as the first dorsal; pectoral with nearly straight distal margin and with rounded corners.

Habits and Food.—This is an inshore species that usually occurs in less

than 10 fathoms and often close to land in bays and harbors, occasionally entering fresh water (Gunter, 1942a). Field (1907) examined the stomachs of over 300 individuals, finding lobsters, rock crabs, lady crabs, spider crabs, hermit crabs, menhaden, razor clams, *Nereis*, and various species of small fish. His estimate of the damage done to the various species of crustaceans and fish is most revealing of the enormous destruction caused by these sharks. A more recent article on the same subject is that by Jessup (1943).

Breeding.—On the northern part of its range, mating takes place in late summer and the young are born between early June and mid-July. The breeding season of the southern stock of the species is not known. "The eggs are fertilized internally, and the young are about twelve inches long when born. From 4 to 12 fish are produced at one time," (Smith, 1907). One female, with almost completely developed embryos, was caught on the 32-mile Bank, Freeport, Texas, March 24, 1940. Springer (1938) examined a number of females taken early in February, at Norfolk, Virginia, which contained an average of 11 embryos each, all at about the same stage of development; i.e., from 200 mm to 260 mm in length.

In this species the embryo is attached to the uterus by a pseudoplacenta.

Economic Uses.—Lawson (1709) says that dogfish were accounted good meat in the Carolinas, but, because of the abundance of better, were rarely eaten. In Bermuda it is called the "Nurse Shark," and is highly esteemed by the negroes as food. At Folkestone, England, dogfish is dried and goes by the name of "Folkestone beef" (Goode, 1884). Oil was formerly obtained from their livers and used for the tanning of leather.

Extensive efforts were made at one time, by the Bureau of Fisheries, to introduce this species as a canned food under the name of gray fish. Unfortunately the attempt did not meet with success.

GALEOCERDO CUVIER (Le Sueur)—Tiger shark

Range.—This large and active shark is worldwide in its distribution, mainly inhabiting tropical seas. Nevertheless it has been recorded from as far north as Iceland (Faber, 1829), and from as far south as New Zealand (Phillips, 1927). Garman (1913) states that it ranges approximately 20° on either side of the equator.

This is one of the most numerous of the larger sharks throughout the West Indian-Caribbean region, where it is to be expected anywhere at any time.

Occurrence in Texas.—Mr. Norman Buell, of the California Packing Company, examined a 400 pound specimen of this shark which was caught 25 miles south of Galveston on July 29, 1940. In addition 2 sets of jaws examined by Baughman, one at Galveston, the other at Port Aransas, proved to belong to this species. Its occurrence at Galveston and Port Arthur is also confirmed by several excellent photographs. One of our most common sharks (Baughman, 1950).

Color.—Gray or grayish brown above; a paler shade of the same below; small specimens up to 5 or 6 feet long are more or less prominently marked

with darker brown spots, often fusing irregularly into oblique or transverse bars; these fade with growth, large ones often being but faintly marked or even plain colored.

Size.—While only 18 to 20 inches at birth, this is one of the larger sharks at maturity with adults averaging about 12 to 14 feet. It is reputed to grow considerably larger still. They may be expected to weigh 700 to 850 lbs at 11 to 12 feet, 850 to 1,300 lbs at 12 to 13 feet, and 1,000 to 1,400 lbs at 13 to 14 feet, depending on fatness and (for gravid females) on the stage of development of the embryos.

Description.—Trunk heaviest opposite the first dorsal and tapering rearward; a low ridge along the mid-line of the back between the two dorsals and a low ridge along each side of the caudal peduncle; snout noticeably short and very broadly rounded; spiracle easily visible as a slit; longest gill opening about 1 1/5 as long as horizontal diameter of eye; upper jaw with a well-marked furrow, extending from corner of mouth to about opposite the front edge of the eye, and furrow on lower jaw about 1/2 that long; teeth 9 to 12 on each side in each jaw, the uppers similar and very characteristic in shape; their edges finely serrate toward the tip but coarsely so toward the base. Second dorsal about 1/2 as long as first and 1/3 as high; caudal very distinctive in outline, with a very slender pointed tip and a narrow sharp-pointed lower lobe a little

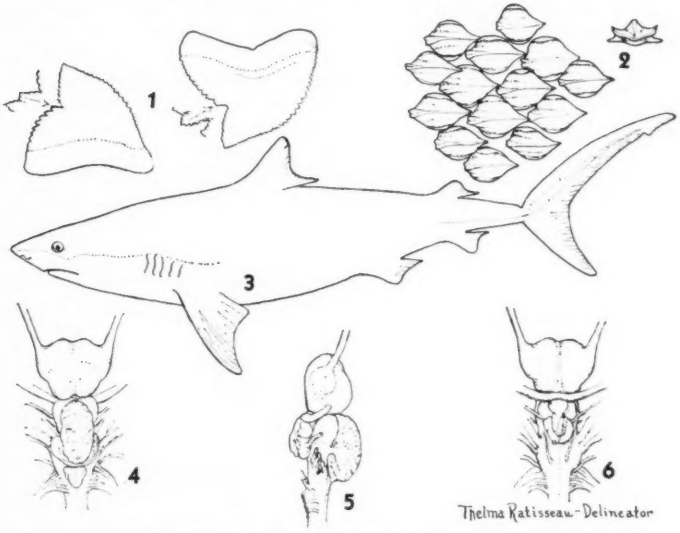

Plate 2. Figs. 1-6. *Galeocerdo cuvier.*—1. Teeth (from *Sharks of the Caribbean*); 2. Denticles (after Radcliffe); 3. *Galeocerdo cuvier* (after Norman and Frazer); 4. Dorsal view of brain (after Garman); 5. Lateral view of brain (after Garman); 6. Ventral view of brain (after Garman).

more than 1/3 as long as the upper lobe; anal similar to second dorsal and below it; pectoral about 1/2 as long as the distance from end of snout to fifth gill opening, with moderately concave distal margin and narrowly rounded corners.

Habits and Food.—This shark is found indifferently far out at sea and close inshore, even on mud flats in very shallow water. Except when pursuing food, the species is sluggish, but when in action it is one of the most vigorous and strong-swimming of the family. Tiger sharks will eat almost anything that they can get. Porpoises, dolphins, turtles, fishes of all kinds, crabs, squids, and shellfish, have all been taken from their stomachs. They are scavengers occasionally (Beebe and Tee Van, 1941), and cannibals frequently, Coles (1919) having taken chunks of hammerhead, sharp-nosed and ground sharks from the stomachs of tiger sharks. Bell and Nichols (1921) found portions of *Mobula olfersi*, whip-rays, and several shad in specimens they examined. André (1784) figures a section of jaw from one in which a stingray's spine had been so long embedded that the normal teeth had disappeared, being replaced by an abnormal and malformed set. Radcliffe (1914) has seen them eat one another, and Longley and Hildebrand (1941) speak of a man-o-war bird removed from the stomach of a three-meter specimen. Coles (*op. cit.*) found a diving bird in one, while Springer (1938) has obtained cormorants and small migratory birds, such as warblers, from individuals taken in Florida. Swordfish form part of their bill of fare (Goode, 1884), and a 400 mm octopus came from a Pacific specimen. Others contained feathers, a sea lion pup, shearwaters, an iguana, and a specimen of *Diodon* which had *not* (*vide* Darwin) eaten its way out through the abdominal wall of its host. On the west coast of Florida, where the horse shoe crab (*Limulus*) is abundant, this item forms a considerable part of the diet. Among the keys most stomachs contain one or more opercula of the horse conch (*Fasciolaria gigantea?*). At least two specimens from the waters of that state contained parts of men. These were caught in 1943, one on the east coast, one on the west, and while there is no way of knowing whether the men were alive when eaten, MacCulloch (1926) has noted such an attack in Australian waters.

The varied diet of this shark occasionally leads to an accident in which the jaw or teeth become malformed. Gudger (1937b) notes several instances of this kind.

Breeding.—The oviducts of *Galeocerdo* are bilateral and functional, but in four specimens examined, the left ovary was small and always non-functional, the right being large and functional with eggs in the anterior part (Gudger, 1940). Here the young undergo development before birth.

Tiger sharks are extremely prolific; Young and Mazet (1934) mention 57 obtained from one mother. Springer (1940a) examined three gravid females, one of which contained about 34 eggs in an early stage of development. This fish was caught in May, as was another female which contained 37 embryos, 21 ♂ ♂ and 16 ♀ ♀. Another large tiger shark, caught in March, contained 18 embryos, of each sex. Early and late embryos were also taken

in March, and very early ones in June. The March embryos averaged 620 mm in length, against 500 mm for those caught in May. Springer (1938) did not believe that there was any specific period of the year during which this species was born. However, in 1940, he stated that tiger sharks were present in the waters off Englewood, Florida, throughout the year, mating there. Since then additional information points toward a spring breeding period.

Economic Uses.—From a commercial point of view, tiger sharks are of considerable value, contributing largely to the catch of the shark fisheries. The skin is tough, having a tensile strength six to ten times that of oxhide (Norman and Frazer, 1938). The liver yields from 60% to 80% of oil, which yields about 35 units of Vitamin D, and up to 5,000 U. S. P. units of Vitamin A per gram of oil (Springer, 1944). Mr. Springer states (1938) that there is a correlation between the liver oil content of this and other Atlantic sharks and the development of the young. A high oil content is present when there are ripe ova in the oviducts, and a low oil content is found when nearly full term embryos are present. It would be most interesting to know if the seasonal variation of oil and vitamin content noted by Byers (1940) in Pacific sharks also depends upon their breeding season.

Tiger sharks are eaten in the West Indies. Fowler (1915) notes a four-foot specimen in the fish market at Trinidad. The meat is similar to that of the nurse shark, and good either fresh or salted. In 1945 tiger shark meat commanded a price of 8c per lb from Florida dealers for all that could be obtained.

SCOLIODON TERRA-NOVAE (Richardson)—Sharp-nosed shark, Newfoundland shark

Range.—This shark was originally described by Richardson (1886) from a specimen taken off Newfoundland. Subsequently it was discovered that it was extremely widely distributed, being known from the Bay of Fundy south to Brazil (Miranda-Ribiero, 1918) and Uruguay. However, Breder (1929), considers it only a straggler north of New Jersey. It occurs as far east as the coast of Africa (Fowler, 1936) and is one of the more common fish throughout the West Indian-Caribbean complex, being so plentiful locally as to be a nuisance in some sections because of its habit of taking baits intended for more desirable fish. Meek and Hildebrand (1923) obtained a number of specimens at Panama.

Occurrence in Texas.—Nineteen specimens collected by Baughman and now in the U. S. N. M. (Cat. No. 116448-116451) are from Galveston, Texas. This is, as far as we can determine, the first mention of the species from this state (Baughman, 1950), although Weed collected a specimen (F. M. N. H. 10913) in the Laguna Madre at Point Isabel in August, 1924. A specimen in the British Museum was collected by Brandt in 1852, "from Texas." Mr. Buell obtained 8 averaging 14.5 lbs each.

Color.—Brownish to olive gray above, with the dorsal and caudal fins more or less dark-edged; white below.

Size.—About 11 to 16 inches at birth; adults commonly 26 to 30 inches long; maximum recorded length about 36½ inches.

Description.—Trunk slender; the snout flattened above, tapering to narrowly rounded tip and varying considerably in shape in different specimens; gill openings a little longer than the diameter of the eye, the fourth over the origin of the pectoral; a well-marked furrow, extending around the corner of the mouth and for a short distance along each jaw, is a distinctive character among similar species; the teeth, similar in the two jaws, are also distinctive in shape—those along the sides of the jaws being broader than high, smooth edged and very oblique, with the outer margins deeply notched. The base of the second dorsal fin about 1/3 as long as that of the first dorsal but similar to it in shape, its origin about over the mid-point of the base of the anal; lower lobe of the caudal a little more than 1/3 as long as the upper lobe; the anal similar to the second dorsal in shape but about 1 1/3 as long at the base; the pelvics a little longer at the base than the anal, being only about as long as the front edge of the first dorsal; the pectorals noticeably small with moderately concave distal margin and well rounded tip.

Habits and Food.—*Scoliodon* is often taken right along the beach. It is also found in enclosed bays, sounds, harbors, and occasionally in brackish and even in tidal fresh water (Gunter, 1942). It has never yet been taken over a

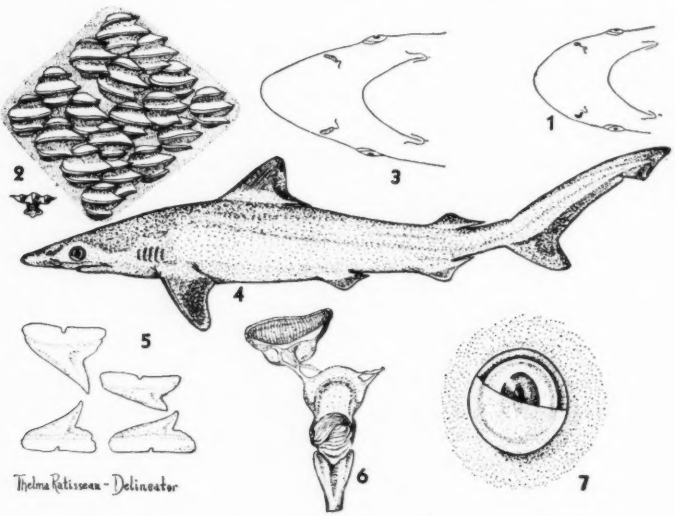

Plate 3. Figs. 1-7. *Scoliodon terra-novae.*—1. Broad-nosed type of head (from *Sharks of the Caribbean*); 2. Denticles (after Radcliffe); 3. Sharp-nosed type of head (from *Sharks of the Caribbean*); 4. *Scoliodon terra-novae* (after Garman); 5. Teeth (from *Sharks of the Caribbean*); 6. Dorsal view of brain (after Daniel); 7. Eye (after Garman).

mile or two out at sea. The food of this species consists largely of fish and crustaceans, and the stomachs of specimens examined by Radcliffe (1914) in July contained hog fish, silversides, Irish pompano, shrimp, and the feet of mollusks. Linton (1904) obtained fragments of fish and shrimp, pieces of sea lettuce, crabs of various species, crustacea, annelids, menhaden, and toad fish from other specimens taken at the same locality. Another specimen (Gudger, 1910) had in its stomach "3 eels (*Anguilla rostrata*)."

Breeding.—The young are born chiefly in the late spring and summer in the northern part of their range, but the season is not well known for tropical waters, although Springer (1938) states that new born are frequently caught in the Mississippi sounds during August. With this species, as with other littoral sharks, the males and females apparently separate during the bearing season.

Gudger (1915b) has described the utero-gestation of this shark. He says: "In a 37½ inch specimen, taken at Tortugas, the left ovary was twice as long as the non-functional right lobe, while the oviducal apparatus was paired, symmetrical, and had both sides functional. The eggs, each enclosed in a thin yellow shell with its long pointed ends curiously folded and plated, lay in crypt-like lateral 'nests' formed in the mucal lining of the uteri. . . . In all respects, the eggs and their shells, together with the uteri containing them, are in close parallel with similar structures in the bonnet-head shark, *S. tiburo*. . . ."

Radcliffe (1914) examined another female 101.6 cm in length taken August 9, at Beaufort, N. C. This specimen contained "four embryos, 3 females and a male, 5.5 to 6 cm in length. . . . These were attached to the yolk-sac, and still possessed the mass of long, thread-like, external gill filaments. . . . In addition to the embryos, the ovary contained a number of small eggs."

Economic Uses.—These sharks have little commercial value, their small size at maturity, about 3 feet, militating against their use as a source of leather. However, in some places they form an important source of food. The Mexican Servicio de Pesca lists them, under the name of "Cazon," among the food fishes of Merida, Yucatan, and Mr. J. H. Martinez of that place, informs me that they form a staple food. He says:

"The 'Cazon,' a small sized fish, that belongs to the shark family, commands the highest price, because it keeps for days when dried over fire. . . . They come about October, in large schools along the Yucatan shores, are readily caught in large numbers. . . . In Campeche it is the staple food for families rich and poor."

It should be noted, however, that there are at least six or seven species of shark which come under the generic heading of "Cazon," and it is not definitely known how large a proportion of the catch is actually represented by *Scoliodon*.

APRIONODON ISODON Muller and Henle—Smooth-toothed shark

Range.—Atlantic Ocean, having been recorded from New York (Gunther, 1870), Cuba (Poey, 1875), and Virginia. The most recent records are those from North Carolina (Radcliffe, 1914), South Carolina (Burton, 1940), and

Florida and Mississippi (Springer, 1938). It has also been recorded from Africa (Fowler, 1936).

Occurrence in Texas.—A dried jaw from the Laguna Madre, August 25, 1924 (F. M. N. H. 10,917) and a 432 mm female collected by Baughman at Galveston, Texas, July 7, 1940, are, according to Mr Springer, who identified the Galveston shark, the only known Texas specimens of this rare shark. However, a third is in the collection of the National Museum under the Accession No. 156479. This specimen is also from Galveston; and a fourth (F. M. N. H. 10,918) is in the Field Museum.

Color.—Slate blue above; pure white below.

Size.—The largest so far reported was about 4 feet long but it may grow considerably larger.

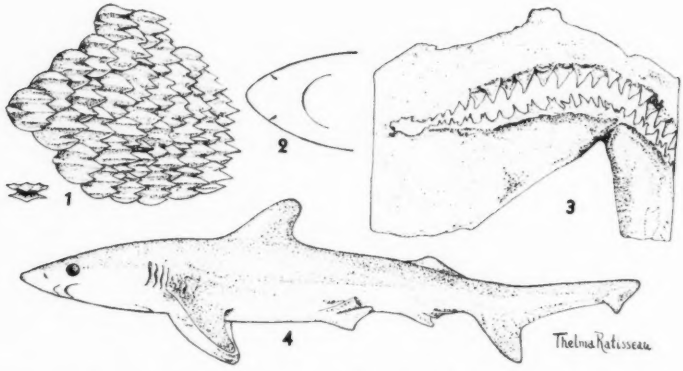

Plate 4. Figs. 1-4. *Aprionodon isodon.*—1. Denticles (after Radcliffe); 2. Ventral view of head (after Springer); 3. Teeth (after Radcliffe); 4. *Aprionodon isodon* (after Radcliffe).

Description.—Trunk rather slender; snout moderately pointed; gill opening noticeably large (the species' most obviously distinctive character), the longest being more than twice as long as the diameter of the eye and 2/3 as long as the snout in front of the mouth; furrows on the jaws very short, the lower usually concealed when the mouth is closed; teeth very slender, needle-sharp, on broad bases, rather widely spaced, about 13 to 15 in each side of the mouth on each jaw. The second dorsal fin about ½ as long at the base as the first dorsal and stands over the anal; lower lobe of the caudal between 1/3 and 1/2 as long as the upper lobe; anal with posterior margin much more deeply concave than that of the second dorsal; pectorals small, being only about 1/2 as long as the head (snout to fifth gill opening), with only slightly concave distal margin and a narrow tip.

Habits and Food.—No data available.

NEGAPRION BREVIROSTRIS (Poey)—Lemon shark

Range.—Both sides of the Atlantic; from Brazil and the West Indies north to Charleston and Pensacola, occasionally straying as far as New Jersey (Anon., 1945). It has been reported by Meek and Hildebrand (1923) from Panama, and is known to occur in the Bahamas, and off Cuba and Jamaica.

Occurrence in Texas.—One specimen of this shark was obtained in Lydia Ann Channel, lower Aransas Bay, in May, 1942, by Gunter (1945). This is the only record for the state.

Color.—Usually yellowish brown above, but sometimes dark brown or bluish gray with yellowish tinge; white or pale yellowish below, the anal usually yellowish and edged with gray; the other fins with or without dark edges.

Size.—Matures at about 7 to 7½ feet and grows to a maximum length of about 11 feet.

Description.—Trunk moderately stout; snout very short and broadly rounded; gill openings about 1½ to 2 times as long as the diameter of the eye; teeth narrow, triangular, with smooth-edged cusps, those toward the corner of the mouth increasingly oblique and with their outer edges notched; second dorsal fin very nearly as large as the first dorsal (this is the most distinctive character of the shark among the local members of its family); lower lobe of the caudal about ½ as long as the upper lobe; posterior margins of the anal much

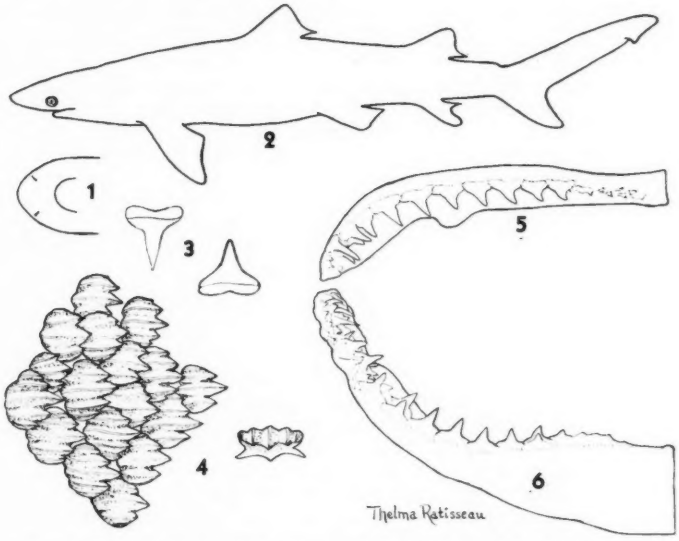

Plate 5. Figs. 1-6. *Negaprion brevirostris.*—1. Ventral view of head (after Springer); 2. *Negaprion brevirostris* (after Springer); 3. Teeth (after Springer); 4. Denticles (after Springer); 5, 6. Upper and lower jaws, resp. (after Radcliffe).

more deeply concave than that of the second dorsal; pectoral about $^2/_3$ as broad as long, thus relatively broader than in other related species of the region.

Habits and Food.—This is an inshore species common around docks, which it frequents in search of refuse (Breder, 1929). It also frequents creeks and inlets as well as the open coast, where it subsists largely on fish, including stingrays in its diet. It has also been accused of attacking bathers.

Breeding.—Four litters of young, all taken in May, at Englewood, Florida, represented 55 individuals. The average length was 502 mm.

Economic Uses.—Rogers (1919) notes that a 95-pound specimen of this shark furnished the following economically useful products:

	Weight	*% of Total*
(Hide 7¼ square feet)	10.5 lb.	11.9
Liver	9.75 lb.	10
Edible Food	29.75 lb.	31.3
Flesh for fertilizer or chicken food	42.5 lb.	44.7
Blood and other fluid	3.0 lb.	2.1

In the above figures, the fins were included with the fertilizer. A little over 3 quarts of oil were obtained from the liver.

Rusoff (1940) examined two livers of this species, each weighing about 20 pounds. Four gallons of dark colored oil were obtained after a three-hour cooking with live steam. The specific gravity of this oil was 0.9118, and the vitamin content amounted to over 15,000 U.S.P.X. 1 units of Vitamin A per gram. This yield is much above the average of Florida sharks, however, for Springer (1944) states that the majority of this species produces oil assaying between 3000 and 11,000 U.S.P. units of Vitamin A. The Vitamin D content is around 35 units.

This shark produces good heavy leather, and all the fins are utilized in commercial operations, while the flesh which Rogers (1919) notes as excellent, is now on the market both fresh and filleted.

CARCHARHINUS LEUCAS (Müller and Henle)—Cub shark, requiem shark, bull shark

Range.—Bermuda, the West Indies, the tropical Atlantic and Mediterranean, straying northward to Massachusetts. Springer (*op. cit*)* remarks that this shark ranges from Carolina to Texas, but actually it is found much farther to the south. Jordan and Dickerson (1908)* obtained a specimen 2 $^1/_3$ feet long at Tampico, "evidently identical with the specimens collected by Dr. Jordan at Galveston in 1882,"* and Mr. Springer states that a Cozumel Island specimen (U.S.N.M. 37131) collected by Bean (1890) may possibly be referred to this species, although originally labeled *Carcharias coeruleus* DeKay. Present indications are that its center of abundance covers the West Indian-Caribbean region generally as far north as northern Florida and no doubt the

southern part of the Gulf of Mexico as well. Throughout this area it is, in fact, one of the more numerous members of the genus, if not the most numerous. In the warmer parts of its range it occurs throughout the year.

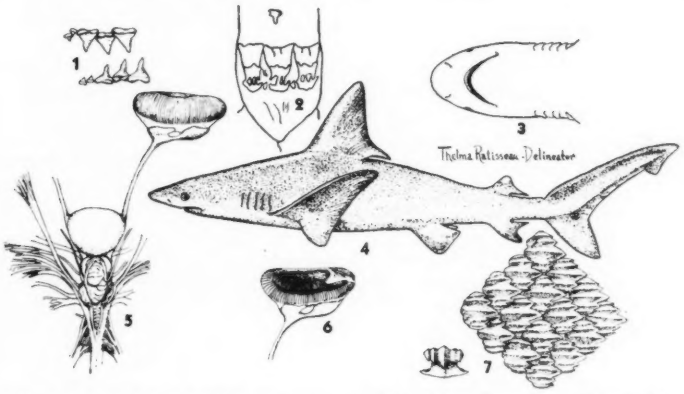

Plate 6. Figs. 1-7. *Carcharhinus leucas*.—1. Teeth (after Garman); 2. Heart valves (after White); 3. Ventral view of head (after Garman); 4. *Carcharhinus leucas* (after Garman); 5. Dorsal view of brain (after Garman); 6. Nasal sac, bissected (after Garman); 7. Denticles (after Radcliffe).

Beebe and Tee Van (1933) report this species from the Pacific.

Occurrence in Texas.—This large and heavy-bodied shark was first recorded from Texas by Jordan and Gilbert (1883).* Springer (1938)* lists it as does Reed (1940).** It is one of the largest sharks of the Texas Coast in summer, and is freqeuntly caught at Aransas Pass by sportsmen on rod and line. A specimen, (F.M.N.H. 10921)* was taken by A. C. Weed, in Brazos Santiago Pass, near Port Isabel, Texas, on September 23, 1924, and Mr. Buell obtained a 250 lb specimen at Galveston in 1940 (Baughman, 1950). Our most common shark.

Color.—Gray above, varying from pale to dark apparently according to the color of the bottom over which it is living; white below. Adults do not have any conspicuous fin markings.

Size.—Matures at a length of about 7 feet. This species grows to 10 feet or a little more. Reported weights are 250 to 375 pounds at 8 to 8½ feet and 400 pounds at 10 feet.

Description.—*C. leucas* differs from all other Atlantic members of its family, except for *Negaprion brevirostris* and *Pterolamia longimanus* in its extremely short and very broadly rounded snout, combined with the fact that there is no ridge along its back. The fact that its second dorsal is much smaller

* as *C. platyodon*.

** Both as *C. platyodon* and as *C. commersoni*.

than its first dorsal is, however, enough to mark it off at a glance from the first of these. A relatively shorter and broader pectoral, the shape of the first dorsal fin, and the fact that the rear tip of its anal fin is far from the point of origin of the lower lobe of the caudal, separate it from the adults of the *C. longimanus* that may lack the mid-dorsal ridge.

Habits and Food.—A heavy, slow swimming species, most common inshore in shoal water; often caught around docks, and at the entrances to passages between islands and keys; it also runs far up into freshwater, Gunter (1938) noting one* caught at Simmesport, Louisiana, in the Atchafalaya River, 160 miles from its mouth. The species is also represented by a landlocked form (*C. nicaraguensis*) in Lake Nicaragua. *C. leucas* is an indiscriminate feeder, its stomach contents being similar to those of *Galeocerdo*. It eats all sorts of fish, both large and small, including stingrays, whose spines are found in its jaws (Nichols, 1917). Black-tipped sharks (*C. limbatus*), pieces of *Mobula* and shad, the fin of a porpoise, crabs and mackerel, all have been taken from its stomach (Bell and Nichols, 1921) and Linton (1904) notes the plate of a sea urchin and a few thin strips of vegetable fiber in a stomach examined by him.

Breeding.—Apparently the young are born in late winter and early spring. "A solitary female* had the left ovary small and the right large with eggs in the anterior part. . . . Both oviducts were well developed and functional" (Gudger, 1940). A female examined by Springer (1940a)* contained 6 embryos averaging 710 mm in length. Of these 5 were males. A female caught at Beaufort, N. C., on July 25, contained 4 small embryos, while a female from Key West contained 6 young, 17 to 18 inches long. Newborn young, 25 inches long, were caught in Florida in February (Nichols, 1917).

Economic Uses.—The skins, fins, and liver of this shark are all used commercially. The skin is somewhat lighter in weight than that of the tiger shark, or of *Negaprion*, but good. The liver produces an oil which is rated at about 35 U.S.P. units of Vitamin D per gram. The Vitamin A content is relatively high, ranging from 5000 to 45,000 U.S.P. units per gram.

The fins are regularly used, being of good grade, and the meat, commonly eaten in Bermuda, is white and clear, making excellent food either fresh or in filleted form. Nichols (1917) says that it resembles swordfish in flavor.

CARCHARHINUS POROSUS Ranzani

Range.—Originally named by Gilbert (1896) from a Bay of Panama specimen, *C. porosus* was later reported from Guayaquil, Ecuador, by Starks (1906)* and from the Galapagos. This shark has also been reported from the west coast of Mexico, but until Baughman (1943)* reported it from Texas, the only specimens known from the Gulf of Mexico were the 13 obtained by Meek and Hildebrand in the market at Colon, Panama.*

* As *C. cerdale.*

Occurrence in Texas.—Since the publication of Baughman (1943) A. C. Weed has very kindly called attention to specimens obtained by him. Two (F.M.N.H. 10,910 and 10,914) were taken in the Laguna Madre, Point Isabel, Texas, during August, 1924. Six others (F.M.N.H. 11,199 to 11,204) were taken at the same place.

Descriptive Notes.—The following data were furnished by Mr. Springer on a 362 mm female collected by Baughman at Galveston and now in the Museum of Comparative Zoology at Harvard. "There is no interdorsal skin ridge. The nostrils are oblique, nearer the mouth than the tip of the snout, with a slender, rather long nasal flap. Note that the snout is rather abruptly narrowed at the nostrils; i. e., the outer angle of the nostril to the eye forms a straight line, and the outer angle of the nostril, nearly to the snout tip is a straight line. The anal is in advance of the second dorsal. The origin of the first dorsal is in advance of the inner distal angle of the pectoral but behind the inner proximal of that fin. The pectoral is neither falcate nor especially large. The 362 mm female is probably young, but no umbilical scar shows, indicating small size at birth.

"*Denticles.*—The denticles are three-ridged, the ridges strong, with the posterior points projecting and the points sharp but not heavy. The denticles are not imbricate; are wider than long, and spaced, although not so widely as in *C. milberti.* The skin is rough, the size of the denticles moderate. This is a small specimen but it is not probable that denticle size or arrangement would change greatly with size. In older specimens I would expect less tendency to overlap, less imbrication, more ridges perhaps, but not as many as five or seven.

"*Teeth.*— $\frac{13\text{-}0\text{-}13}{13\text{-}0\text{-}13}$. Both upper and lower teeth are strongly serrate, the serration being coarser than in most *Carcharhinus* in comparison to the size of the specimen. The upper teeth are triangular, notched on the outer edge. The lower teeth are erect.

"*Color.*—On this specimen there is no trace of a lateral stripe such as is present on *C. limbatus* and many other carcharhinid sharks. The fins, except the caudal which has the upper lobe dark, are not tipped or colored with any darker shade. The darker upper color does not extend so low as on many sharks, *C. natator,* etc., and the eye is surrounded by white except at the top."

No data available on size, habits and food, breeding, or economic uses.

CARCHARHINUS ACRONOTUS (Poey)

Range.—Poey described this shark from Cuba, and until recently there were no records of the species from the northern Gulf of Mexico. However, Schroeder (1945) states that a specimen was caught at Biloxi, Mississippi.

Occurrence in Texas.—A single specimen, collected near Corpus Christi by Reed, is in the Chicago Museum of Natural History. The identification was made by Mr. Loren P. Wood (Baughman, 1950).

No data available on size, habits and food, or breeding.

Economic Uses.—This species is used by the Cubans for food.

CARCHARHINUS LIMBATUS (Müller and Henle)—Spot fin shark

Range.—This fish is commonly distributed throughout the tropical waters of the Atlantic, straying as far north as Wood's Hole, Massachusetts, and Nichols (1929) states that it makes up the bulk of the shark population on tropical and warm temperate shores. Fowler (1936) has recorded it from a number of West African locations, while Meek and Hildebrand (*op. cit.*) obtained specimens from Chaime Point and Panama City on the Pacific side of the Isthmus of Panama. It is common in Brazil, around the Bahamas, off southern Florida and in the northern part of the Gulf of Mexico.

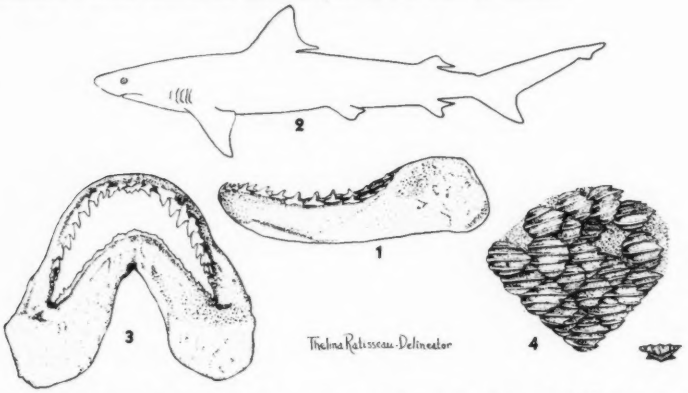

Plate 7. Figs. 1-4. *Carcharhinus acronotus.*—1. Lower jaw (after Radcliffe); 2. *Carcharhinus acronotus* (after Springer); 3. Upper and lower jaws (after Radcliffe); 4. Denticles (after Radcliffe).

Occurrence in Texas.—Gunter (1945) obtained a specimen 130.5 cm in length in Lower Aransas Bay, June 17, 1941. Eight small specimens ranging in size from 32.5 to 44 cm in length were obtained in the Gulf of Mexico, off Port Aransas. These lengths being less than those of full term embryos as given by Springer (1938), it is possible that they were *Carcharhinus natator* Meek and Hildebrand, a species found on this coast. Mr. A. C. Weed took five in the Laguna Madre, at Point Isabel, in August, 1924. These are F.M.-N.H. specimens Nos. 10911, 10915, 10916, 10919, 10920. Mr. Buell obtained 8 at Galveston on July 19, 1940, which averaged 51.9 lbs each. On July 22, he obtained 2 averaging 46.7 lbs, and on July 29, 2 more, which average 58.5 lbs each.

Color.—Dark gray, dusky bronze or ashy bue above; white (pure or yellowish) below, with a band of the dark upper color extending backward along each side, and with the pale hue of the lower parts extending forward. In the adult, the pectorals are conspicuously tipped with black. In young specimens the dorsals, the anal and the lower lobe of the caudal are also tipped with black.

Size.—Maturing at 4 to 5 feet, adults average about 5½ to 6½ feet. Few grow longer than 7 feet, with 8 feet about the maximum. Recorded weights are

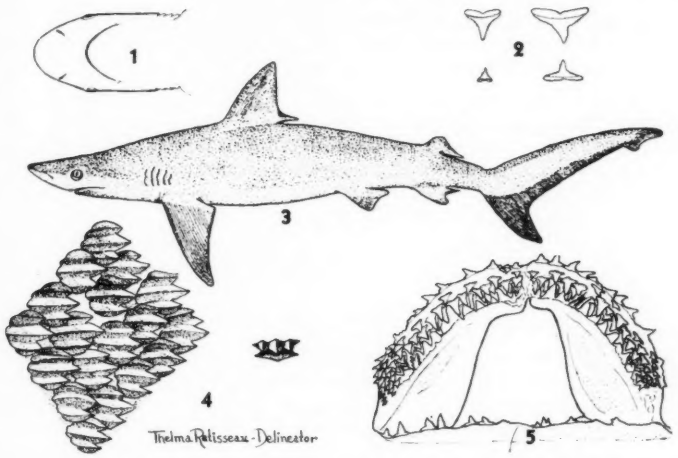

Plate 8. Figs. 1-5. *Carcharhinus limbatus.*—1. Ventral view of head (after Garman); 2. Teeth (after Garman); 3. *Carcharhinus limbatus* (after Garman); 4. Denticles (after Radcliffe); 5. Lower jaw and teeth (after Gudger).

about 4 pounds at 28 inches, about 20 pounds at 4 feet, about 42 pounds at 5 feet, and 68 pounds at about 5½ feet.

Description.—Among the members of the genus in which the back does not have a ridge, *limbatus* resembles *maculipinnis* in its conspicuously black-tipped fins and in the fact that its upper teeth toward the center of its mouth are slender, erect and symmetrical. It differs from *maculipinnis*, however, by its relatively large eyes, by its shorter gill openings, by the fact that the free rear tip of its second dorsal is less slender, and by the fact that the edges of its lower and upper teeth are regular though finely serrate. (They are smooth in *maculipinnis.*)

Habits and Food.—An active, swift shark often seen in schools at the surface, and frequently leaping clear of the water. The food of *limbatus* is generally fish, and Nichols (1917) mentions a specimen in which two stingray spines were imbedded about the mouth. Gunter's (1945) large specimen had two spines embedded in the internal body wall.

Breeding.—Data for six females with young are available from Florida.

Location:	Date	Length	No. of Young	Length of Young
Rabbit Key*	4/4	5 ft. 5 in.	3♂ 3♀	21-22 in.
Marco*	4/5	5 ft. 3 in.	0♂ 6♀	23 in.
S. of Sanibel Lt.*	4/7	5 ft. 3 in.	2♂ 2♀	22 in.
Off Sandy Key*	4/13	5 ft. 2 in.	3♂ 0♀	about usual
Englewood, Fla**	Jan.	(2 females)	6♂ 6♀	14 in.

* Nichols, 1917. ** Springer, 1940.

Evidently the Englewood specimens were not completely developed. With this, as with other carcharhinid sharks (Thorne, 1928), males do not appear to accompany the females to the bearing grounds.

Economic Uses.—This shark is commonly used as food by the poor in Port Rico (Evermann and Marsh, 1900) and Brazil (Nichols and Mowbray, 1917). Mr. Nichols, who has eaten it, says that the flesh is beautifully white and decidedly palatable. The hides are small, and thinner than are desirable for the American trade, but would be useful as a specialty leather. The fins are not so good as those of other species, generally grading No. 2. The potency of the liver oil varies, that of Florida specimens ranging up to 25,000 U.S.P. units of Vitamin A per gram (Springer, 1944).

CARCHARHINUS NATATOR (Meek and Hiildebrand)*

Range.—This shark had previously been reported only from Panama, the type locality, two having been found in the Panama City fish market. However, Baughman (1942a) reported a number of specimens from Galveston, Texas, the first known occurrence in the waters of the United States.

Food.—The stomach of one gravid female contained a solitary specimen of the Gulf menhaden, *Brevoortia patronus* Goode.

Breeding.—Large numbers of this species have been observed along the west beach of Galveston Island in the month of June. All the adults examined were gravid females containing fully developed embryos. Along with these females were numbers of small sharks of the same species in which the umbilical scar was still very pronounced. Ten females that were opened contained 39 embryos. Of the 10 litters of young so examined, one consisted of 4 embryos not checked for sex. In the remaining 35 the sex ratio was approximately 22% males to 78% females, actual counts being 1:3, 1:2, 1:3, 1:3, 1:3, 1:3, 1:3, 1:3, 1:3, the smaller number in each case representing the males. In none of the litters examined were more than two embryos contained in a single lobe of the uterus. The young were approximately 15 inches long at birth, while most of the adult females ranged between 4 and 5 feet in length. In all, both females and young, the large falcate pectorals are a most noticeable feature. No adult males were seen.

EULAMIA SPRINGERI (Bigelow and Schroeder)

Range.—Bigelow and Schroeder (1944) list the species as occurring from Florida to Yucatan. Presumably this includes Texas (Baughman, 1950).

Description.—The following data are those given by Bigelow and Schroeder for the type:

"*Study material:* Type specimen, female, 805 mm in total length, Cozumel, Yucatan, U. S. Nat. Mus. No. 37,141; also probably of this species is a somewhat shrivelled skin, with head, also female, about 1390 mm in total length, Englewood, Florida, Mus. Comp. Zool., No. 35,900.

* See Springer, 1950.

"*Color.*—After preservation, the type specimen is olive gray above, and of a paler shade of yellowish olive below, without conspicuous fin markings, either dark or light.

"*Size.*—The fact that the type specimen still shows the umbilical scar, although 805 mm long, suggests that this is one of the larger members of its genus.

"*Distinctive characters.*—*E. springeri* most nearly resembles *E. obscurus*, with which it agrees in general, so far as relative sizes and positions of fins are concerned, and in the presence of a mid-dorsal ridge. But it differs in a number of features (in combination) from specimens of *obscurus* of approxi-

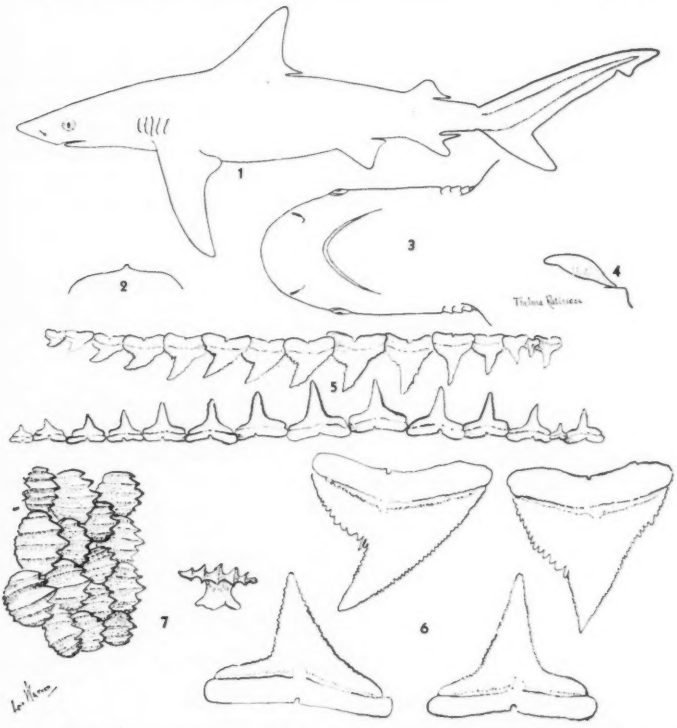

Plate 9. Figs. 1-7. *Eulamia springeri.*—1. *Carcharhinus springeri* (after Bigelow and Schroeder); 2. Cross section of back between first and second dorsal fins, to show dermal ridges (after Bigelow and Schroeder); 3. Ventral view of head (after Bigelow and Schroeder); 4. Nostril (after Bigelow and Schroeder); 5. Upper and lower teeth (after Bigelow and Schroeder); 6. Fourth and eighth upper teeth and third and ninth lower teeth, counted from symphysis (after Bigelow and Schroeder); 7. Dermal denticles (after Bigelow and Schroeder).

mately the same size, with which we have compared it: (a) its eye is considerably larger, relative to the lengths of the gill openings; (b) the anterior margin of its nostril is expanded as a low, triangular lobe (not lobed in *obscurus*); (c) its first dorsal is relatively larger and more erect, but with its free rear corner relatively shorter and the posterior margin less deeply concave; (d) its second dorsal is larger in area, but shorter—origin to rear tip—relative to its vertical height; (e) the distance from the tips of its pelvics to the origin of its anal is considerably shorter (about 0.7 the anal base in *springeri*, but 1.3 the anal base in *obscurus*); (f) the outer corners of its pelvics are only about a right angle (about 115° in *obscurus*); (g) its denticles have a larger number of marginal teeth and of ridges in specimens of equal size; and (h) its upper teeth are more strongly oblique, more deeply incised outwardly, and more coarsely serrate basally than those of *obscurus*.

"Among carcharhinids of the west coast of America, *springeri* resembles most nearly *platyrhynchus* Gilbert, 1891, in its teeth, and in its fins. But the length of its snout (in front of mouth) is considerably less than the breadth of the mouth (a little longer than the breadth of the mouth in a specimen of *platyrhynchus*, with which we have compared it); and its fins show no trace of the white edgings that are so conspicuous in *platyrhynchus*, differences that seem sufficient to demand recognition in nomenclature, and especially so in view of the geographic discontinuity between the areas of occurrence of the two sharks in question.

"*Springeri* is sharply separated from *galapagoensis* Snodgrass and Heller, 1905, the teeth and snout of which are similar, by the shapes of the first dorsal and pectoral fins, by its much larger eye (relative to the lengths of the gill openings), and by the fact that its second dorsal is only very little smaller than its anal in area."

EULAMIA OBSCURUS (Le Sueur)—Dusky ground shark

Range.—Both sides of the Atlantic, in tropical and warm temperate waters. From southern Massachusetts to southern Brazil off the American coast. *Obscurus* has often been confused with other species, but it is certainly common throughout the year off the east coast of Florida where large ones are often taken on set lines. It is probable, too, that it occurs generally throughout the West Indies and Caribbean, for it has been reported from the Bahamas, from Trinidad, from British Guiana, as well as from Brazil. To the northward, young ones often range as far as southern New England in summer.

Occurrence in Texas.—Several specimens of this shark were taken off Port Aransas in 1949 during an experimental shark fishery carried on by the Marine Laboratory of Texas Game Fish and Oyster Commission (Baughman, 1950).

Color.—Bluish or brownish or leaden gray above; grayish or pure white below, except that the lower surfaces of the pelvics are grayish and sooty toward their tips.

Size.—Born at a length of about 34 to 40 inches, it grows commonly to a length of 10 to 12 feet and is reputed to reach 14 feet though perhaps not on any positive grounds.

Description.—Among ridge-backed members of this genus (of which it is one), *obscurus* most resembles *milberti*. In fact, it has often been confused with it. It is easily separable from it, however, by the fact that the vertical height of its first dorsal fin is considerably less than the distance from the eye to the first gill opening, and also that it originates farther toward the rear. It differs from the other ridge-back species *falciformis* and *floridanus* in the shapes of its second dorsal and anal fins as well as of its teeth; from *longimanus* in the facts that the tip of its first dorsal fin is not broadly rounded and that the tip of its anal does not fall near the point of origin of the lower lobe of the caudal.

Habits.—About all that is known of its habits is that it is taken both close inshore as well as farther out at sea and that it is a fish eater. In Floridan waters, groupers and various other reef fishes, as well as portions of other sharks, have been found in its stomach.

Breeding.—Present indications are that it produces young throughout its geographic range and over a long season.

EULAMIA MILBERTI (Müller and Henle)—New York ground shark
brown shark, sand bar shark

Range.—In the western Atalntic from southern Brazil to New England. It is still an open question whether repeated reports of its presence in the Mediterranean and from neighboring parts of the eastern Atlantic actually refer to the same species. This is perhaps the most numerous of the sharks that are caught in southern Florida in winter. It may occur generally in the Caribbean also at that season, for it has been recorded from Yucatan and from the coast of Nicaragua. In summer, on the other hand, so many visit the coast of the United States betweeen New Jersey and Cape Cod, that there is record of fourteen of them harpooned by one single fishing boat near New York in one day. But it is not known whether the entire stock shares in this migration, or whether some remain in more southern waters throughout the year.

Occurrence in Texas.—We have no positive evidence of the occurrence of this shark in Texas. Nevertheless its indicated range is such that its presence in these waters is very probable. We include it here because of this reason alone, and for the sake of completeness.

Color.—Varying from slate gray to brownish gray or brown above, perhaps depending on the color of the surroundings; a paler tint of the same hue or white below. The fins have no conspicuous markings.

Size.—Usually about 22 inches long at birth, it matures at about 6 feet; occasionally growing to 8 feet or so. Weights are from about 100 pounds at 6 feet to about 200 pounds at 7 feet 8 inches.

Description.—*E. milberti* is one of the ridged-backed members of the genus. It is easily recognizable among other species with this feature by the large size of the first dorsal fin (its vertical height is about as great as the distance from the eye to the second-third gill opening) and by its position far forward with its origin over the center of the pectoral, combined with the fact that the free

rear margin of its second dorsal is only about as long as the base of that fin. The scales on the sides are also much more loosely spaced than in other local members of the genus.

Habits.—An inshore species, most often seen at river mouths, in shallow bays and similar places. It is often taken in pound nets or harpooned, but it seldom shows at the surface. It feeds chiefly on small fishes—including skates and dog fish, a wide variety of which have been found in its stomach—also on crabs, bivalves, mollusks and octopuses to some extent.

Breeding.—Seemingly its young are produced chiefly in the northern parts of its range in summer. So far as it is known, it is wholly harmless.

PRIONACE GLAUCA Linnaeus—Blue shark

Range.—This great shark is a pelagic species, distributed throughout the temperate and tropical waters of the world. In general, its range is similar to that of *Galeocerdo.* Vladykov (1935) reports it from Nova Scotia banks; Bigelow and Schroeder (1927, 1940) regard it as fairly common in the Gulf of Maine. On the eastern side of the Atlantic it has been seen as far north as the Orkneys, and fishermen in the English channel consider it a nuisance, as it often destroys their nets in its efforts to reach the catch (Dunn, 1900). It is common in the Mediterranean; Fowler (1936) gives numerous West African occurrences, and Biden (1934) says it reaches Mossel Bay, just east of the Cape of Good Hope. Blue sharks have been recorded several times from New Zealand (Philipps, 1927), while in Australia the species is considered dangerous to bathers, a fact mentioned both by MacCulloch (1926) and Cleland (1930). Numerous other records for eastern seas are also given by Fowler (1941).

Occurrence in Texas.—Evidence of the presence of this shark in Texan waters is extremely doubtful. Fishermen at Freeport claim that they catch one occasionally, insisting that they are familiar with the shark from experience in other waters. The Mexican Servicio de Pesca lists the species from the waters of Tamaulipas, just south of the Texan border, with the remark that its chief utility is for the manufacture of fertilizer.

Color.—Living specimens are dark indigo-blue along the back, shading to a clear bright blue along the sides to snow-white below. They soon fade after death to a slaty or sooty gray.

Size.—Born at a length of 20 to 30 inches and maturing at about 7 to 8 ft, the blue shark grows commonly to 10 to 12 ft. While it is credited with reaching 15 to 20 feet, there is no positive proof of this. Beacuse of their slender build recorded weights are only about 100 to 120 lbs at 7 ft to 8 ft and 150 to 200 lbs at 9 feet.

Description.—Trunk noticeably slender; snout conical with narrowly rounded tip and noticeably long; gill openings short, the longest about as long as the horizontal diameter of the eye (this relationship alters somewhat with growth); in the upper jaw there are 14 teeth on each side (sometimes with smaller tooth at the center), and in the lower jaw 13 to 15 on each side with 1 to 4 small ones in the center, uppers a little broader than long, oblique, their

outer margins deeply concave and inner margins convex and their edges serrate; lower erect, more slender than uppers, usually very finely serrate but occasionally smooth; base of second dorsal fin about ½ as long as base of first dorsal; caudal with narrowly pointed tip and lower lobe, the latter about ½ as long as the upper lobe; anal similar, a little smaller than the second dorsal and below it; pelvics noticeably small, being about as large as the anal; pectoral noticeably long (about as long as the distance from end of snout to the fifth gill opening); only about 1/3 as broad as long, with moderately convex and concave distal margins and narrow tip.

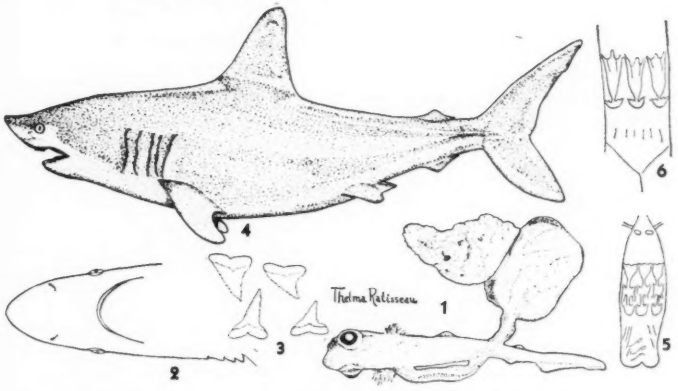

Plate 10. Figs. 1-6. *Prionace glauca.*—1. Embryo (after Beebe); 2. Ventral view of head (from *Sharks of the Caribbean*); 3. Teeth (from *Sharks of the Caribbean*); 4. *Prionace glauca* (after life-sized model in American Museum of Natural History); 5. and 6. Heart valves (after White). Note:—*Prionace* is not this heavy-bodied. The mounted specimen has too great a girth to be typical.

Habits and Food.—This is a pelagic shark, usually found at the surface. Well known to sperm-whalers, from their habit of gathering to gorge on the carcasses of whales, the food of this shark is predominantly fish, which are hunted more actively at night than during the day (Fowler, 1941). Dogfish, conger eels, and gurnards have all been taken from the stomach of one of these selachians, as have mackerel, garfish, and herring (Couch, 1877). Nichols and Murphy (1916) mention a booby (*Sula*) being eaten by another, and go on to state that it also consumes whelks, shell and all, as well as other mollusks. Data on a California specimen are given by Kanakoff (1940) whose paper we have had no opportunity to examine.

Breeding.—Beebe (1934) caught a female off Bermuda which contained, on September 12, 25 embryos in each ovary. These were nearly fully developed and "would have been born before many weeks." In one ovary there were 13 ♂ ♂ and 12 ♀ ♀. Inquiry as to the sex ratio of the other ovary was fruitless, notes on the subject having been misplaced.

Evidently such a number of embryos is not unusual. In *Field and Stream*

for January, 1936, a photograph (p. 78) shows a female blue shark caught off Bermuda, which also contained 50 embryos, from 10 to 14 inches in length.

This species is viviparous.

Economic Uses.—The flesh of these sharks is white and firm, and is used for food in some countries. Natives of the Philippines and other parts of the Orient eat it, and at one time it was an article of food among the poorer classes of Italy (Norman and Fraser, 1938). Occasionally a blue shark is sold as food in the California markets (Walford, 1935).

The skin is said to make excellent leather.

SPHYRNA TIBURO (Linnaeus)—Shovel-nosed shark

Range.—Suppositiously *S. tiburo* is world wide in distribution. On our Atlantic coast it is known as far north as Long Island, and from there is common southward almost everywhere on our coast. Barbour and Cole (1906) note a specimen from Progreso, Yucatan.

Occurrence in Texas.—This, one of the most common sharks of the Texas coast, was entirely omitted from their list by Evermann and Kendall (1894), a fact which seems strange in view of the abundance of the species about Galveston and Corpus Christi, two of their collecting stations. The first published record of *S. tiburo* in Texas waters is that of Fowler (1931) who notes "one dead individual in July on the Gulf beach near Corpus Christi." Reed (1941) also lists the species, but gives no locality record.

On July 11, 1942, approximately 40 specimens of this small shark were taken from seines along the west beach of Galveston Island. That same evening, from a pier in Galveston proper, the author observed a large number of shovel-nosed sharks being caught, anglers bringing in one every few minutes. On July 12, due to a rough sea and moderate wind, seiners were not very active, but from the same pier a good many of this species were again being caught by hook and line fishermen.

Other records are a 31 cm specimen from a shrimp trawl at Aransas Pass, September 16, 1941, and one of 42.5 cm on April 12, near Mud Island, in Aransas Bay. Five specimens from Galveston (U.S.N.M. 116,450) are in the collection of the National Museum, and four (F.M.N.H. 10947-10951) were collected by Weed in the Laguna Madre, at Point Isabel, in August, 1924. Buell (1945) obtained 6 males at Galveston, which averaged 6.15 lbs each.

Color.—Gray or grayish brown above and paler shade of same hue below. Some fish have a few small round dark spots on the sides, but there are no conspicuous fin markings.

Size.—Seldom exceeds 2 feet, with 4 feet about the maximum.

Description.—Trunk moderately flattened sideways; head "shovel"—not "hammer"—shaped, the front contour being an uninterrupted curve from eye to eye without definite depressions opposite nostrils; the distance from nostril to eye is slightly greater than diameter of eye; the corners of mouth are slightly in front of the outer rear corners of the head or "shovel"; diameter of eye about $1/4$ to $1/5$ as long as length of the head in front of mouth; length of

first gill opening about 1½ times diameter of eye; fifth gill opening over origin of pectoral; teeth are in 12 to 14 rows on each side of upper jaw and in 12 rows on each side of lower, with one very small tooth usually in the center of both upper and lower jaw; in the upper jaw the first tooth from center is erect, but the subsequent teeth become increasingly oblique; in the lower jaw the first 1 to 3 teeth are erect, the next 4 or 5 are slightly oblique and the few near corners of mouth are low, oval and have no cutting edge; free rear margin of second dorsal about 1/3 as long as vertical height of fin and not longer than its front margin; pelvics with weakly convex margin and weakly concave rear margin; and rear margin weakly concave.

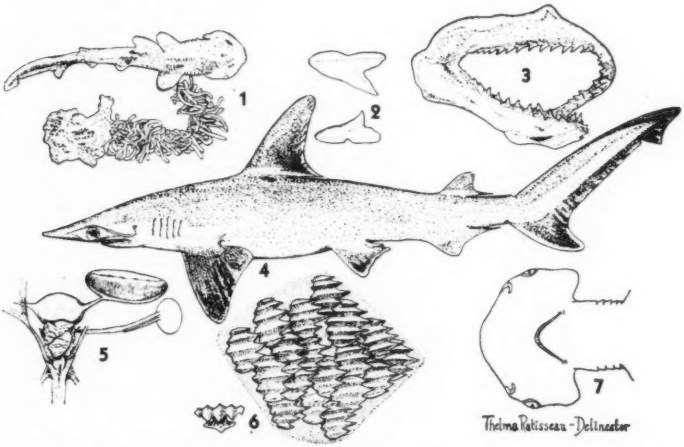

Plate 11. Figs. 1-7. *Sphyrna tiburo.*—1. Embryo, 18 cm long, placenta and billi (after Radcliffe); 2. Teeth (after Garman); 3. Jaws of 147.5 cm female (after Radcliffe); 4. *Sphyrna tiburo* (after Garman); 5. Dorsal view of brain (after Garman); 6. Denticles (after Radcliffe); 7. Ventral view of head (after Garman).

Habits and Food.—This is a shallow water species, being found inshore, generally in less than 5 fathoms, and it often invades bays and estuaries. Crabs form a large part of the diet of this fish (Springer, 1938) and Gunter (1945) says that on the Texan coast the principal species so utlilized is *Callinectes sapidus* Rathbun. A specimen opened by Dr. Longley (Longley and Hildebrand, 1941) contained a small octopus. *Squilla mantis,* shrimp and other crustaceans, a small isopod, *Balanus,* and seaweed have also been found in their stomachs (Linton, 1904).

Breeding.—A specimen taken at Beaufort, N. C., on July 25, 1902, contained 8 young (Smith, 1907). A 92.5 cm specimen taken at the Tortugas contained four young in one uterus, and the other five, each 137 mm long. The walls of the tueri were thin, vascular, and wrinkled, with the delicate egg membrane enclosing each young fish similarly plaited, its folds fitting so closely

within those of the uterus that a perceptible tension was necessary to separate the two (Longley and Hildebrand, 1941).

Economic Uses.—Occasionally used as food, Fowler (1915) noting one three feet long in the Trinidad market. Vitamin A content of liver oil, 900 U.S.P. Units per gram (Springer, 1944).

SPHYRNA TUDES (Cuvier)—The great hammerhead

Range.—*S. tudes* is found in practically all the warm seas of the world. On the North American coast it has been recorded definitely only from Florida, but as it is probable that many of the records for *S. zygaena* are applicable to this species, the limits of its range are not definitely known. Fowler (1936) has recorded it from a number of locations off the West African coast, while the same author (1941) gives an imposing list of its occurrences in the Pacific and Indian Oceans.

Occurrence in Texas.—Known only from a photograph of a shark taken at Port Aransas (Baughman, 1950).

Color.—Small specimens are brownish gray above and a paler shade of the same tint below with the dorsal fins, caudal and upper surfaces of the pectorals dusky toward the tips. Large ones are reputed to be dark olive above and pale olive below without conspicuous fin markings.

Size.—Probably about 28 inches long when born. The largest of the hammerheads, this shark apparently matures at about 10 feet, commonly reaching 13 to 14 feet with 15 feet reported.

Description.—Trunk moderately flattened from side to side. The front contour of head with a depression opposite each nostril and shallow but noticeable indentation at the mid-line of head; the distance from nostril to eye is about equal to diameter of eye; in adults the corners of mouth are slightly behind the rear margin of the head or "hammer," but in newborn and very young specimens the rear corner of mouth is slightly in front; diameter of eye about $1/3$ as long as head in front of mouth in young fish, but increasing so little in size in large ones that it may be only about $1/5$ as long; length of first gill opening about $1\ 1/3$ times diameter of eye in young, but 2 to $3\ 1/3$ times in medium sized specimens and as much as 4 times the eye in large fish (around 10 feet long); 4th gill opening over origin of pectoral; there are 17 teeth on each side of the upper jaw and 16 or 17 on the lower, with 2 or 3 very small upper and 1 to 3 lower teeth in the center of jaw; the teeth are triangular, the first being erect but the remainder becoming increasingly oblique toward corners of mouth; the edges of the teeth are serrate from tip to base excepting the 1 or 2 near corner of mouth—none of our other hammerhead sharks have serrated teeth; free rear margin of second dorsal is about $3/4$ as long as the front margin of the fin and only about as long as its vertical height; pelvics with front margin more strongly convex and rear margins more deeply concave than in any other Atlantic members of this genus.

Habits and Food.—Probably similar to that of *S. zygaena.*

Breeding.—"Three females with embryos have been taken (at Englewood, Florida), all in early June. Of these a twelve-foot specimen contained 30 em-

bryos, and two thirteen-foot specimens contained 37 and 38 embryos, respectively" (Springer, 1938).

In his 1940 paper he notes one female caught in March, 1939, containing 25 embryos, averaging 450 mm in length. Sixteen were males and 9 females. Three litters examined in May contained 62 embryos, 28 males and 34 females, averaging 620 mm in length, and a litter of 31, taken in December, averaged 625 mm. There were 17 males and 14 females in this last.

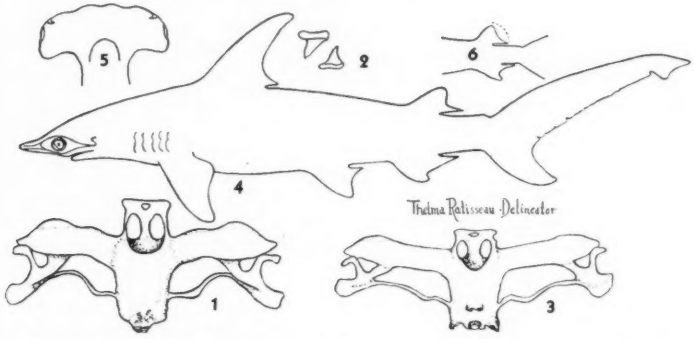

Plate 12. Figs. 1-6. *Sphyrna tudes.*—1. Dorsal aspect male cranium (after Springer); 2. Teeth (after Springer); 3. Dorsal view female cranium (after Springer); 4. *Sphyrna tudes* (from *Sharks of the Caribbean*); 5. Ventral view of head (after Springer); 6. Second dorsal and anal fins (after Springer).

Economic Uses.—The skin of this species is thin and not especially desirable for the American trade. It can be used for some purposes to advantage, however, and is usually sold, although graded down. The liver oil potency ranges from 5000 to 100,000 U.S.P. units of Vitamin A per gram. The fins are good, and the flesh is edible, although as it is soft, it spoils easily. This or the following species is sold in the markets of Jamaica. Gilbert and Starks (1904) state that *tudes* is frequently found in the Panama markets.

SPHYRNA ZYGAENA Linnaeus—Common hammerhead

Range.—*Sphyrna zygaena* is distributed throughout the warm waters of the world, occurring on our Atlantic coast as far north as Halifax, Nova Scotia (Vladykov, 1935).

Occurrence in Texas.—The common hammerhead is listed by Reed (1941) as occurring in Texas waters. A specimen collected by Baughman at Galveston (Accession No. 156,479) is in the collections of the U. S. National Museum, and another at Stanford University, this last identified by Dr. A. C. Herre.

Color.—Deep olive-leaden or brownish gray above, paler on sides, shading into pure or grayish white below; tips or margins or fins more or less dusky; the pectoral fins are black-tipped in some specimens but not in others.

Size.—Born at a length of about 20 inches; adults appear to mature at

about 8 to 9 feet. They are often caught up to 10 or 11 feet and occasionally to 13 feet.

Description.—Trunk strongly flattened from side to side; the front contour of head with a deep depression opposite each nostril and a shallow depression midway between each nostril and the mid-line of the head. The mid-line, however, is evenly convex and has no indentation as has *S. displana* and *S. tudes;* the distance from nostril to eye is only about $1/2$ as great as the diameter of the eye (about as great as eye in *diplana*); the corners of the mouth are slightly in front of the rear margin of the head or "hammer"; diameter of eye about $1/3$ as long as head in front of mouth; length of first gill opening a little less than diameter of eye; fifth gill opening over origin of pectoral fin; the teeth are broadly triangular and there are 15 teeth on each side of upper jaw and 13 on each side of lower jaw which also has a small tooth in the center; the first upper tooth is nearly symmetrical and erect but the others are strongly oblique; the lower teeth resemble the uppers toward corners of mouth except that they are a little smaller, but the 4 teeth next to center of mouth are narrower and less oblique than the uppers; free rear margin of second dorsal is about twice the vertical height of the fin and about equal to front margin; rear margin of anal fin deeply concave.

Habits and Food.—This is a powerful, strong swimming shark often seen at the surface with the tips of the first dorsal and caudal fins exposed. Many are found far out at sea. This hammerhead feeds largely on fish and squid, but, like most of the large sharks, it seems to take almost anything in the way

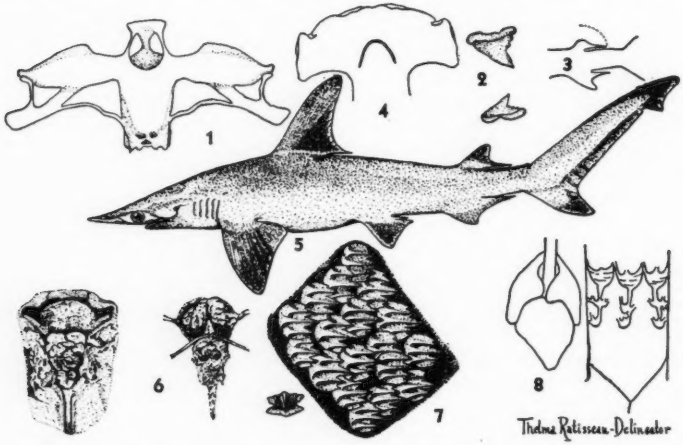

Plate 13. Figs. 1-8. *Sphyrna zygaena.*—1. Dorsal view of cranium (after Springer); 2. Teeth (after Garman); 3. Second dorsal fin (after Springer); 4. Ventral view of head (after Springer); 5. *Sphyrna zygaena* (from *Sharks of the Caribbean*); 6. Dorsal view of brain left-hand figure and ventral view of brain right-hand figure (after Garman); 7. Denticles (after Radcliffe); 8. Heart vales (after White).

of food it can obtain. A specimen, 11 feet 1 inch, taken at Cape Lookout, N. C., on July 19, had been feeding on Spanish mackerel, *Scomberomorus maculatus* and Coles (1919) believes that this is the normal food of the young and active members of the species, although older, solitary specimens were believed by him to exist exclusively on stingrays.

Gudger (1932) has given a most interesting account of this habit. Seeing a big hammerhead chasing stingrays over the sand flats of Beaufort harbor, the shark was harpooned and an examination made of its stomach contents. The almost perfect skeleton of a stingray was discovered, along with portions of others. Further dissection disclosed some 54 spines from the tails of stingarees, *Dasyatus* spp., the eagle ray, *Stoasodon narinari*, and from the pectoral fins of the ocean catfish, *Bagre marina*. All these were imbedded in the jaws of the shark. Fowler (1926) examined another specimen containing three rays, *Dasyatus sabina*, which had, in addition, 17 spines in the stomach and 24 imbedded in the jaws.

Hammerheads are cannibals. Coles (1919) speaks of a 13 foot, 10 inch female which had in her stomach four smaller individuals of her own species.

Oddly enough, *S. zygaena* is one of the few species definitely proven to have attacked a human being in Aemrican waters (Gudger, 1937a).

Dr. Mitchill (1815) states that one of three of these fish, taken at Riverhead, Suffolk County, New York, in 1805, contained many detached parts of a man, together with his clothing, in its stomach.

Breeding.—Hammerheads are viviparous, and the young of a single female may number as high as 36.

Economic Uses.—This hammerhead is considered edible in the Hawaiian Islands, where it is the shark most frequently found in the markets (Cobb, 1905). Day (1865) says that the flesh was considered most nourishing by the natives of Malabar and that it was extensively salted. In Cochin, also, its flesh was considered very wholesome, and the oil extracted from the liver was a favorite remedy for night blindness. However, the natives of Madeira considered the flesh hard, and disagreeable both in smell and taste (Lowe, 1843).

SPHYRNA DIPLANA Springer—Hammerhead

Range.—From Florida to Texas, the west coast of Africa and the Mediterranean (Springer, 1940). *S. diplana* has also been caught in Rio Janeiro and as far north as Delaware. However, records of this form and *S. zygaena* are so mixed that it is hard to demarcate the range of either.

Occurrence in Texas.—Represented by three specimens from Galveston (U.S.N.M. No. 116,449) in the collection of the U. S. National Museum, this hammerhead is so similar to *Sphyrna lewini* Griffith of Australian (Whitley, 1937) and Pacific seas (Fowler, 1941) that it was at first mistaken for this species by Dr. Wm. C. Schroeder and Mr. Stewart Springer when they examined several specimens forwarded to the Museum of Comparative Zoölogy. Two of Weed's specimens from Point Isabel (F.M.N.H. 10952-10954) were also of this species.

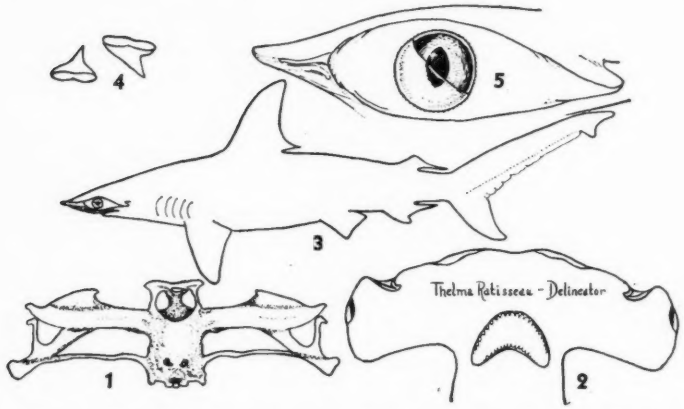

Plate 14. Figs. 1-5. *Sphyrna diplana.*—1. Dorsal view of cranium (after Springer); 2. Ventral view of head (after Springer); 3. *Sphyrna diplana* (from *Sharks of the Caribbean*); 4. Teeth (from *Sharks of the Caribbean*); 5. Eye (from *Sharks of the Caribbean*).

Color.—Light gray above, shading to white below; the pectorals tipped with black on their underneath surfaces.

Size.—A moderately large shark; young are about 16 inches long when born and grow to a length of about 8 feet and probably longer.

Description.—Trunk strongly flattened sideways; head with a slight but noticeable indentation in front in the mid-line (there is no indentation in *Sphyrna zygaena*); the front margin of the head is also scalloped with a deep rounded depression opposite each nostril; the distance from the nostril to the eye is about as long as the diameter of eye (only about 1/2 that long in *zygaena*); the corners of the mouth are well in front of the outer rear corners of the head or "hammer"; a line connecting outer ends of nostrils passes a little in front of the mouth; eye nearly circular, its diameter about 1/3 as long as head in front of mouth; first gill opening a little more than 1 1/2 as long as diameter of eye, the fifth gill opening being above the origin of the pectoral fin; there are 15 or 16 teeth on each side of the upper and lower jaws and usually one or two very small ones in the center of the jaws; the teeth are triangular in shape on expanded bases and the cusps are smooth edged (serrated in *Sphyrna tudes*); the first tooth from the center of jaw is much smaller than the second, and the fifteenth and sixteenth at the corners of the mouth are very small indeed. The free rear tip of the second dorsal is much longer than its vertical height and at least as long as the front margin of the fin; pelvic fins have nearly straight margins and rear margin of anal is deeply concave.

Habits and Food.—Probably similar to *S. zygaena.*

Breeding.—No data available other than Springer's statement that the young have been found around Englewood, Florida.

RHINCODON TYPUS Smith—Whale shark

Range.—The first recorded specimen of this great fish was found in Table Bay, Cape of Good Hope. Others have since been reported from Ceylon, the Gulf of California, Seychelles, the Gulf of Panama, Callao, India, Japan, the Philippines and the Arabian sea. In all Gudger (1915c, 1935) has given a list of "76 definite occurrences . . . distributed as follows: Pacific Ocean, 50 specimens; Indian, 15 fish; Atlantic, 11 specimens." Since that time a number of other individuals have been reported from the Gulfs of Siam and Mexico, and the waters of French Indo-China. Baughman (1948) also calls attention to the fact that this shark was evidently known to the Mortlock Islanders of the Pacific. Dr. Gudger, who knows more about these fish than anyone, is of the opinion that "the waters between northern Borneo and the southern Philippines—the Sulu sea—is probably the center of origin and dispersal of the whale shark."

Occurrence in Texas.—Mr. Stewart Adkins and Mr. B. B. Burnell saw in 1937-38, on the marlin grounds off Port Isabel, a very large shark, estimated at fifty feet in length. Mr. Burnell called it a "basking shark," but as both men described it as having spots within a checkerboard of lines, there seems no reason to believe that it was anything else than a whale shark. There are no published records of any occurrences, however, the closest being those detailed by Gudger (1939) for the Gulf of Mexico. These sharks are also believed to frequent the Campeche Banks. See also Baughman, 1950.

Color.—Upper parts dark grayish, reddish or greenish brown, conspicuously marked with round white or yellow sopts and with a variable number of white or yellow cross stripes. Lower parts are plain whitish or yellow.

Size.—The smallest specimen yet measured was 6 feet long, the largest about 45 feet. It is credibly reported to grow to a length of 60 feet or even

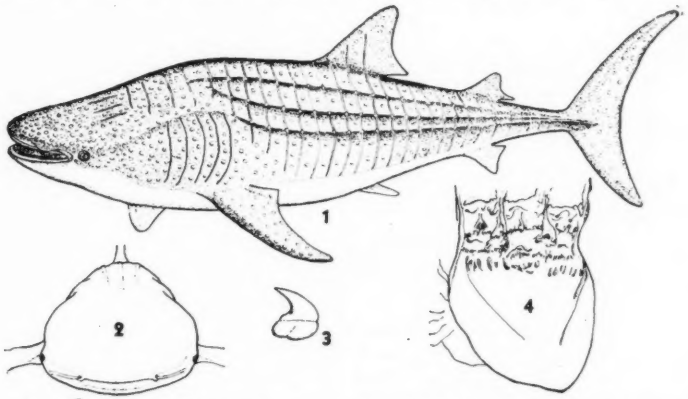

Plate 15. Figs. 1-4. *Rhinodon typicus.*—1. *Rhinodon typicus* (after mounted specimen in American Museum of Natural History); 2. Front view of head (from *Sharks of the Caribbean*); 3. Tooth (from *Sharks of the Caribbean*); 4. Heart (after White).

more. The estimated weight of one of 38 feet was 26,594 pounds. The size at which sexual maturity is reached is not known, nor is it yet known whether or not the eggs hatch within the mother before birth.

Description.—Trunk rather stout with two prominent ridges along each side; head broadly rounded in front without any distinct snout; the mouth at the front tip of the head (this character is unique among West Indian sharks); nostril very close to mouth but not connected with it; eye very small; gill openings large but high up on the sides of the neck; the fifth gill opening over the origin of the pectoral fin; teeth similar in the two jaws, conical, very small, in 10 to 15 functional series and very numerous—an 18-foot specimen having a total of about 3,600 in each jaw and larger specimens still more. First dorsal fin overlaps pelvics; second dorsal only about $^1/_3$ as large in area as first; lower rear edge of upper lobe of caudal is not notched near the tip (it is so notched in most other local sharks); lower lobe about $^3/_4$ as long as upper; pelvics only about as large as second dorsal; and pectoral with noticeable concave distal margin.

Habits and Food.—For a period of 85 years after its first description little was known concerning the feeding habits of *Rhincodon*. Smith (1844), Gill (1905) and Bean (1905) conjectured, from the dentition and from the structure of the gill-rakers, that it fed in the manner of right whales, upon the small animals of the sea. Wright (1870) found masses of algae in the stomachs of 2 specimens dissected by him, and at first believed that these sharks were vegetarians. Later (1879) he stated that their food might consist of "minute crustacea and other oceanic animal forms."

Weber-Van Bosse (1899) helped to perpetuate the vegetarian fable without any real reason for so doing.

Haley (1883) noted "finely divided red matter" in the stomach and this Gudger (1936a) mentions as occurring in a specimen caught at Fire Island Light, being of the opinion that this consisted of "the broken up, hard parts of crustacean exoskeletons." Günther, (1890) says, "it is reputed to feed upon tang," a statement that needs confirmation. A sucking fish found in one is mentioned by Kishinouye (1901) and Van Kampen (1908) took cuttlefish bones, gobies and *Saurida* from a Batavian specimen. Rivero (1937) says that it feeds upon sardines, bonitos, and squid, while standing vertically in the water, but adduces no positive data to this effect.

It remained for Gudger (1941a and 1941b) from whose paper most of the foregoing was taken, to finally produce a factual account of the food and feeding habits of this great shark. From motion pictures taken off the Bahamas, and from correspondents in Cuba, the Seychelles and California, he has definitely established the fact that these sharks do feed upon plankton to some extent. However, due to the comparative scarcity of these organisms in the tropical and sub-tropical waters inhabited by *Rhincodon*, the greater part of its food must necessarily be furnished by other organisms, namely, sardines, and, as Van Kampen and Rivero (*op. cit.*) have shown, squid.

The actual method of feeding resembles somewhat that described by Breder 1925) as a characteristic of *Lobotes* and *Promicrops*.

Association with other Fishes.—In connection with its feeding the whale shark is so constantly found in association with various carangids, bonitos and tunas, which also feed upon the sardines, that in the Seychelles the appearance of either *Caranx gymnosthoides* or the whale shark is regarded as a sure sign of the presence of the other fish. (Gudger, *op. cit.*)

Off the coast of Hondo, Japan, the whale shark and the striped bonito are in constant association, and when the shark basks at the surface as it sometimes does, the bonito crowd together around it. On the California coast this same habit has been noted among the tuna.

Such crowding is evidently a manifestation of a habit exhibited by many other fishes, namely, that of concentrating in some numbers around a larger floating object. Baughman (1942a) noted this among the dorados (*Coryphaena hippurus*) and Beebe (1928) retails a similar instance in which the fish were jacks, *Caranx latus*. It is also a characteristic of ling (*Rachycentron canadus*) which have been found associating with the whale shark in Texas waters (Baughman, 1950).

Breeding.—No data are available on this, although Gudger (1915c) expresses the belief that this shark may be viviparous.

ALOPIAS VULPES Gmelin—Thresher shark, fox shark, sea fox

Range.—A large pelagic shark of the temperate seas, *Alopias* is known from Formosa to Natal and from England to the Cape of Good Hope. On American coasts it seems to be fairly common, and has been reported from as far north as the Atlantic banks and the Bay of Fundy (Vladykov, 1935). It is also found in the Mediterranean and Adriatic seas.

Occurrence in Texas.—This shark is listed by Cross and Parks (1937) as occurring in Texas waters, but "this is a compilation from other sources and is not based on actual records but on suppositions as to probable geographic range, at least so far as many species are concerned. . . . About ten years ago (i. e., 1931) a specimen was captured in a beach seine on Mustang Island, about 3 miles from the north end of the island. It was mounted and is now in the shop of Roberts and Brundrett, taxidermists, at Port Aransas, Texas. It measures 165 cm in total length" (Gunter, 1941).

Color.—Back and upper sides varying from bluish or slaty gray to almost black, shading to white below, but with the lower surface of the snout and of the pectorals sometimes as dark as the back. The belly is sometime more or less mottled with gray.

Size.—Born as small as 3 to 4 feet, but probably does not mature until about 14 feet long, including the tail. It commonly grows to 16 feet occasionally to 20 feet. Recorded weight from 300 to 320 pounds at 10 feet to about 500 pounds at 14 to 15 feet, with a maximum of perhaps 1,000 pounds.

Description.—Trunk rather stout; caudal peduncle noticeably flattened sidewise without lateral keels but with well-marked pit above though there is none below; snout short and broadly egg-shaped; gill openings noticeably short, the longest only a little longer than the diameter of the eye; mouth broadly rounded; teeth about 20 on each side in upper jaw and 21 in lower, similar in

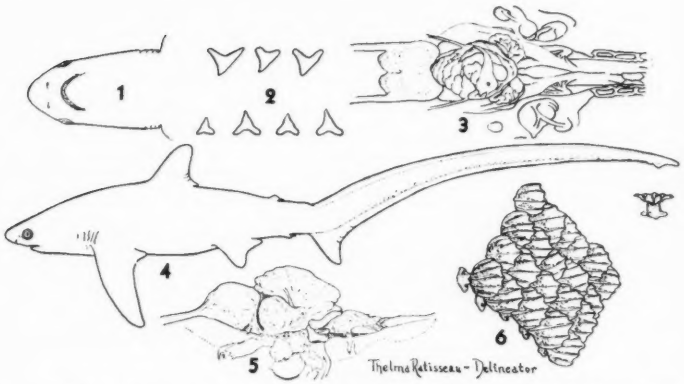

Plate 16. Figs. 1-6. *Alopias vulpes*.—1. Ventral view of head (after Garman); 2. Teeth (after Garman); 3. Brain from above (after Garman); 4. *Alopias vulpes* (after Garman); 5. Brain from the side (after Garman); 6. Denticles (after Radcliffe).

the two jaws with single cusp, triangular, but with concave outer and convex inner margins and increasingly oblique toward the corners of the mouth; the third upper tooth (counted from the center of the mouth) only about $1/3$ as large as those on either side of it. First dorsal fin with rounded tip, its rear tip far in front of the origin of the pelvics; second dorsal only about $1/8$ as long as first; caudal (its most striking feature) occupying approximately $1/2$ or more of the total length of the shark, its upper lobe narrow and scythe-shaped, its lower lobe only about $1/8$ to $1/9$ as long as the upper; anal similar to second dorsal in size and shape; pectoral noticeably large, being as long as or even longer than the distance from its origin to the tip of the snout, about $1/2$ as broad as long, with rounded tip, deeply concave distal margin and noticeably wide base.

Habits and Food.—Threshers feed mostly on schooling fishes such as herring, shad, pilchard and mackerel. One taken in the Firth of Forth had half a bushel of garfish in its stomach (Norman and Frazer, 1938). Both Coles (1919) and Allen (1923) have given descriptions of the feeding habits of this fish and the use of its long and flexible tail. In general it may be stated that it uses this organ to frighten the fishes of a school into a compact mass, swimming round and round them, threshing the water until the smaller fish are closely jammed, when it dives into them with open mouth. A pair of threshers will sometimes work together in this fashion "herding a school" (Bigelow and Welsh, 1925).

Threshers do not attack and eat whales, despite the long established myth to that effect. The many stories of thresher sharks and swordfish acting in unison to smite the leviathan may be put down to poor observation and the normal human failing of making much out of little. Townsend (1923) has given an interesting account of most of the versions of this story and has shown

that, in all probability, such attacks may be attributed to a mammal, the orca, or killer whale.

Breeding.—An 18-foot specimen of this shark, taken off Cuba in January, 1933, contained 2 embryos, each 28 inches long to the tip of the caudal fin (Rivero, 1936).

Economic Uses.—The thresher is, according to Walford (1931), "probably the commonest of the large sharks seen in the fresh fish markets of southern California." The Japanese and Chinese also make some uses of this fish as food, and Couch (1877), states that the Greeks ate it. Moreover, Fr. Joannus Caius (John Keys) says in his work "De Canibus Britannicis," that the fish is not unlike salmon, but that it was "not quite as agreeable to the palate as that fish."

In other parts of the world it has not been looked on with favor. Dr. Ward (1776) says that it was called the sea fox because of the length of its tail and the musky smell of its flesh, which is not unlike that of the fox. In the Adriatic where these sharks are occasionally taken, Faber (1883) says that large sharks were the food of the poorer classes, possessing a most disagreeable smell when opened. He does not specify as to the edibility of this species. Storer (1867) considered them almost valueless. "Its liver, however, contains a small quantity of oil, and when an individual is accidentally taken, this is preserved and sold with the oil from other species."

ISURUS OXYRINCHUS Rafinesque—Mackerel shark, mako shark

Range.—This shark ranges from Cape Cod to the West Indies, occasionally straying north to Maine. Several specimens have been taken about the Bermuda (Beebe and Tee Van, 1933) and it is supposedly common in the Gulf of Mexico (Garman, 1913).

Occurrence in Texas.—Known in Texas only from the vicinity of Port Isabel, where several have been caught by marlin fishermen.

Color.—Deep blue above in life (often appearing cobalt or ultra-marine-blue in the water), but soon fading to a dirty slate-gray; snow white below.

Size.—Maturing at a length of about 6 feet, this shark grows to a maximum length of around 12 feet; recorded weights are 135 lbs at about 6 feet, about 300 lbs at 8 feet, and about 1,000 lbs at 10 feet, 6 inches; largest West Indian specimen so far taken on rod and reel weighed 786 lbs.

Description.—Trunk tapering both toward snout and toward tail; caudal peduncle much flattened above and below but broadly expanded sidewise as a prominent sharp-edged keel on each side, with a deep transverse furrow above and below close in front of the origin of the caudal; snout conical and below close in front of a minute pore or slit; gill openings noticeably large, the first to the fourth about as long as the snout (in front of mouth); teeth similar in the two jaws, 12 or 13 on a side, both above and below, their edges perfectly smooth, the first two in each jaw the largest and the most slender; flexuous in outline; the third upper tooth much smaller than the second or fourth; the teeth along the sides of the jaws more triangular. First dorsal fin high and triangular; second dorsal fin only about $^1/_7$ to $^1/_8$ as long as the first dorsal;

caudal crescent in outline, its lower lobe about ¾ as long as the upper; anal similar to second dorsal in size and shape. Pectoral noticeably long and narrow (a little less than ½ as broad as long), with rounded tip and weakly concave distal margin.

Habits and Food.—This is one of the great sharks of the sea, swift swimming, high leaping, a vicious fighter, tireless and indomitable, that will leap, time after time, when hooked, and it is a favorite with sportsmen on that account. It is found near land and far out in the ocean, where it preys on

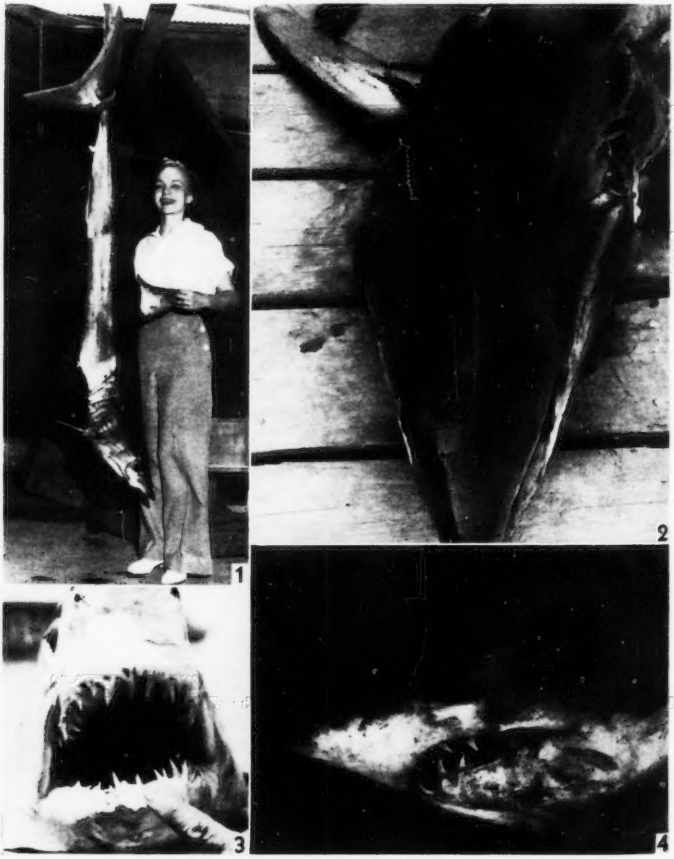

Plate 17. Figs. 1-4. *Isurus oxyrinchus.*—1. A small *oxyrinchus* from Port Isabel, Texas; 2. Dorsal view of anterior portion of body of *Isurus oxyrinchus;* 3. Ventral view of head showing teeth; 4. Lateral view of head of *Isurus oxyrinchus.*

small fish such as mackerel, herring and other schooling species. Murphy (1919) mentions a half grown female caught near Ambrose light, off New York Harbor, that contained a quantity of the remains of large bluefish. They also attack larger species such as swordfish.

Breeding.—Data on the breeding of *Isurus* are scanty. However, if we consider *I. oxyrinchus* and *I. spallanzani* synonymous, as do Bigelow and Schroeder in their revision of the elasmobranchs, we have a most interesting description of the eggs and embryos left us by Vaillant (1899). He described an embryo, the total length of which was 19.65 inches. Attached to the embryo was a yolk sac measuring 5.5 x 9.25 inches. Although the ova and embryo had been in alcohol more than 50 years, Vaillant says: "Le poids total de cette pièce, qui répresente en somme un oeuf gigantique do selacien, est dans état actual de conservation, de 3 kil. 250 grams" (or 7.2 pounds).

As Gudger (1940) remarks, this is almost incredible were it not for the fact that other members of the isurid family are known to produce ova of almost equally huge proportionss. He goes on to cite Doflein (1906) who obtained two eggs of an isurid while collecting in the Sagami Sea of Japan. These ova were "Considerably larger than an ostrich egg" and the embryos were not connected to them by an umbilical cord, but rather grew directly from them. Lohrberger (1910) examined two of Doflein's embryos. The larger was 21.8 inches long and was attached to a yolk sac measuring 8.3 x 4.8 inches, while the whole thing weighed 5.9 pounds.

Material is available on other members of the family. Shann (1910) described embryos of *Lamna cornubica* from Scottish waters. Gudger (1940) gives data on this latter form as does Day (1890).

Economic Uses.—These and other large sharks of the same genus are quite palatable, resembling swordfish in texture and flavor, and they are often sold in the markets.

CARCHARODON CARCHARIAS (Linnaeus)—Great white shark, man eater

Range.—This shark is found throughout the temperate and tropical zones of all oceans, offshore and inshore, but is not plentiful anywhere. It occurs in the western Atlantic, even as far north as Nova Scotia and the Banks south of Newfoundland. To the south, it has been reported from southern Brazil.

Occurrence in Texas.—A female, seven feet and six inches long, 12 miles southeast of Port Aransas, in 15 fathoms, February 9, 1950. Another female, eleven feet and six inches long, from the same locality, on February 16. A third, twelve feet and two inches long, was caught on February 26. The first recorded occurrence in Texas (Baughman, 1950).

Color.—Specimens seen have been slate gray or almost black above, dirty white below, with a prominent black spot on the axils (armpits) of the pectorals. The tips of the pectorals are also more or less spotted with black on the lower surface. Large ones have been described as much paler or even leaden white.

Size.—One of the largest of sharks, apparently not maturing until 13 or 14

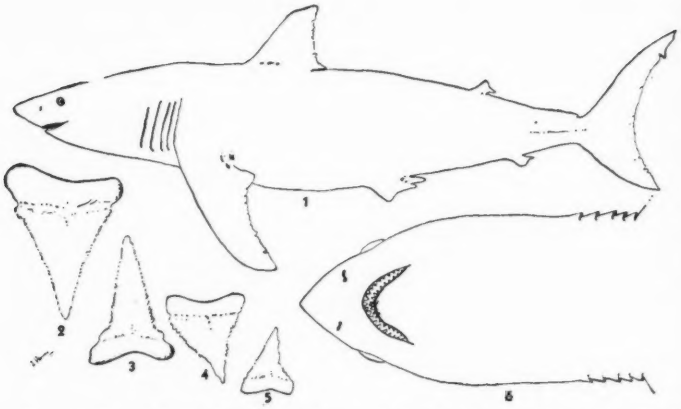

Plate 18. Figs. 1-6. *Carcharadon carcharias.*—1. *Carcharadon carcharias* (from *Sharks of the Caribbean*); 2. Upper fourth tooth (from *Sharks of the Caribbean*); 3. Lower fourth tooth (from *Sharks of the Caribbean*); 4. Lower fifth tooth (from *Sharks of the Caribbean*); 5. Lower eighth tooth (from *Sharks of the Caribbean*); 6. Ventral view (from *Sharks of the Caribbean*).

feet long, often growing to 16 to 20 feet and, at least occasionally, to 30 to 36 feet. The largest West Indian specimen (Cuban) positively measured was 21 feet. One of 8 feet may be expected to weigh about 600 pounds, increasing to 900 to 1,000 pounds at 9 to 10 feet, to about 1,300 pounds at 13 feet, with a recorded weight of 7,000 pounds at 21 feet.

Description.—Trunk stouter than that of the mako, but tapering similarly rearward, with the caudal peduncle flattened above and below and expended widely sidewise as sharp-edged keels; also with a deep transverse furrow above and below close to the origin of the caudal fin. Snout conical, but relatively shorter and less tapering than in the mako (often distorted, however when heavy specimens are dragged up the beach by the upper jaw); spiracle pore-like or lacking; the longest gill opening between $1\frac{1}{2}$ and 2 times as long as the snout (in front of mouth). Mouth more broadly rounded than in the mako. Teeth (its most distinctive feature), 12 on each side of upper jaw and 11 or 12 in lower, with coarsely serrate edges; the uppers triangular, about as broad as high, with nearly straight edges; lowers narrower, their margins more concave; one (at most two) series functional; the first dorsal nearly an equilateral triangle, with narrow tip; second dorsal only about $\frac{1}{5}$ to $\frac{1}{6}$ as long and as high as first; caudal crescent, its lower lobe about $\frac{4}{5}$ as long as the upper; anal similar to second dorsal, its origin close behind the base of the latter; pectorals noticeably large, nearly $\frac{1}{2}$ as broad as long, with rounded tip and strongly concave distal margin.

Habits and Food.—The white shark is the man eater of legend and story. Huge, powerful and voracious, its speed and ferocity have given birth to many

a tale, some of them unfounded, some of them with a solid basis of truth. Opportunities for examining the stomach contents of this species have been limited, but it is known to feed on prey as large as sea turtles, other sharks, seals and similar animals. It also consumes smaller fishes, squid, and is a scavenger of no mean ability.

Breeding.—Sanzo (1912) published on the inter-uterine embryo of this species.

Economic Uses.—Flesh sold for food, it being very palatable.

SQUALUS ACANTHIAS Linnaeus—Dogfish, spiked dog

Range.—Both coasts of the Atlantic, extending from Labrador to Cuba, on American coasts.

Occurrence in Texas.—Reed (1941) lists this species as occurring in Texas, but gives no data. However, it is probable that he examined a specimen of *Squalus cubensis* instead.

Color.—Slate colored above, sometimes tinged with brown; the sides irregularly marked with small white spots, (except in very large specimens on which they may be lacking); grayish or pure white below.

Size.—Born at a length of 9 to 13 inches; males mature at 24 to 32 inches, females to 28 to 40 inches; adults (both sexes included) average from 2 feet to 3½ feet long and 7 to 10 pounds in weight; a few grow to 4 feet, perhaps longer.

Description.—This dogfish closely resembles *Squalus cubensis*, but is easily distinguished from the latter by the facts that the inner corner of its pectoral is rounded and the inner margin only weakly concave, also that the point of origin of its first dorsal (or first dorsal spine) is over or behind the inner corner of the pectoral when the latter is laid back and that its sides are usually spotted with white.

Habits.—An inhabitant of the continental shelf, *Squalus* is rarely found in water deeper than 100 fathoms. It often occurs in large schools and at times is extremely common locally. In the northern part of their range, dogfish migrate northward and inshore in spring, southward and offshore in autumn. Templeman (1944) found that they cover from 3 to 8 miles per day. One tagged dogfish migrated from St. John's, Newfoundland to Massachusetts at least 1,000 miles in 132 days. The limited results from tagging and general information on the sizes of the young indicated the possible mixing of dogfish stocks on the eastern coast of North America.

Food.—Dogfish feed upon squeateague, menhaden, croakers, mackerel, (Jessup, 1943), and other fishes smaller than themselves, crabs, squid, worms, shrimps, prawns, and even ctenophores (Bigelow and Welsh, 1925). Templeman (*op. cit.*) examined 1171 of these fish, and his table of their stomach contents is given below:

Quality	Percentage of stomachs in which present	Number of stomachs in which present
Total stomachs examined	1171	100.0
Empty	665	56.8
Bait cut up by fishermen (herring, mackerel, pieces of cod, embryo dogfish)	367	31.3
Fishes: (not bait)		
Herring	20	1.7
Caplin	7	0.6
Cod	7	0.6
Blenny	1	0.1
Unrecognizable or semi-digested fish fragments	45	3.8
Crustacea:		
Amphipoda	60	5.1
Shrimp	3	0.3
Spider crab	1	0.1
Mollusca:		
Squid. *Illex illecebrosa*	1	0.1
Whelk. *Buccinum undatum*	1	0.1
Polychaeta: Nereis or similar species	2	0.2
Coelenterata:		
Sea anemone	9	0.8
Jellyfish. *Aurelia aurita*	2	0.2
Oddities: (probably thrown over by fishermen) Fat pork	1	0.1
Feet and bones of seabird	1	0.1
Algae:		
Green alga	1	0.1
Brown alga. *Agarum*	1	0.1
Brown alga. *Laminaria*	1	0.1
Red alga. *Ptilota*	2	0.2

"The surprising feature is the large number of empty stomachs, 57 percent, which when added to the approximately 30 percent with nothing in the stomach except herring or other bait cut with a knife into small pieces and easily recognizable as such, made a total of about 87 percent with stomachs empty of food (except bait).

"The food obviously captured by the dogfish was usually in very small amount and consisted of other fishes, Crustacea, Mollusca, Polychaeta, Coelenterata and Algae. Herring were present in 1.7 percent, Caplin in 0.6 percent, Cod in 0.6 percent and one stomach contained a small blenny. In addition unrecognizable or semi-digested fish fragments were present in 3.8 percent of the stomachs. Large herring 10 to 12 inches long were generally bitten in two to five pieces. In one stomach a complete 12 inch herring was found with only

one bite in it and not bitten in two. In each of several stomachs the complete two-thirds of a 12 inch herring was found. The largest cod found was 11 inches long, whole, but almost bitten in two, one inch behind the head.

"5.1 percent of the stomachs contained from 1 to 5 amphipods ranging from ½ to 2 cm in length. In 3 cases 1 to 3 shrimp 1 to 3 cm long were found and in 1 stomach there was a small spider crab. The presence of tiny amphipods, not however, in large enough numbers to furnish any appreciable amount of food, even in many of the largest dogfish, probably reflects the hunger indicated by the large number of empty stomachs. Since these amphipods are so tiny they would often be missed among partially digested food and the true percentage of stomachs containing amphipods is probably considerably higher than the 5.1 percent recorded.

"Mollusca were found in only two stomachs, in one the head and tentacles of a squid *Illex illecebrosa* and in the other a specimen of the whelk, *Buccinum undatum*, 3 cm long. Two stomachs each contained one free living polychaete worm, 9 contained 1 to 2 specimens partly digested of a red sea anemone, 1 to 2 cm diameter, while 2 contained the jellyfish *Aurelia aurita*, in one case a complete specimen 10 cm diameter and in the other case portions of a larger specimen.

"Algae were present in 5 stomachs. One contained green algae, 2 brown and 2 red. Only a small amount of alga was present, 1 or 2 sq. cm in the case of *Agarum* and *Laminaria* and a dozen branching filaments of *Ptilota*."

Breeding.—Dogfish are viviparous. The most complete account of their reproductive cycle is that given by Templeman (1944). He says:

"The two sexes are born in equal numbers. It is probable that in the dogfish visiting Newfoundland in the summer time the eggs are fertilized and pass into the uteri between February and June, and that after a uterine developmental period of almost 2 years, the young are liberated usually between January and May. Owing to the two year developmental period a generation of tiny embryos enclosed in egg-capsules and a generation of large embryos a year older can usually be found at the same time in different females. The tiny embryos grew from an average length of 0.2 cm in July to about 3.9 cm in November, while the large embryos grew from 15.59 cm in July to 21.43 cm in November. The growth of the young in the uterus is a typical S-shaped growth curve. There is no significant difference between the growth of male and female embryos in the uteri.

"By a study of growth of embryos during approximately two years of uterine life, European data on dogfish in their first free living year, and information on growth of females before and after sexual maturity, a growth curve for dogfish has been constructed. From this curve it has been calculated that it takes the average female dogfish 9 or 10 years from the fertilized egg or 7 to 8 years after birth to reach sexual maturity. Some females would grow faster and reach maturity several years earlier. The average male is estimated to mature at 6 or 7 years of age or 4 or 5 years after birth with the possibility of some fast growing specimens maturing 2½ or 3 years after birth.

"Immature females are slightly heavier than the males at all sizes above 60 cm and the mature females are significantly heavier than either mature males or immature females. The largest mature male weighed was 5.0 lbs and measured 86 cm while the largest female weighed was 11.1 lbs and measured 99 cm.

"The number of large yellow eggs in the ovaries, of tiny embryos in the uteri and of large embryos in uteri all increase rapidly with the increase in the length of the parent dogfish. The large yellow eggs of females with large young in uteri averaged 4.2 per dogfish, the number of tiny young 3.98 per parent dogfish and the number of large embryos 3.88 per parent dogfish. Explanations are given of the differences in these averages.

"The length of the larger embryos, the size of the large ovarian eggs, and the average weight per egg of uterine egg-capsules all increase with increasing size of the adult fish while the average length of the tiny embryos decreases as adult size increases. It is concluded that the smaller eggs of smaller dogfish are fertilized earlier.

"The number of embryos in the right uterus is significantly greater than that in the left.

"The ovarian eggs of females with tiny young are small and show small increases in diameter and volume during our period of investigation while the large eggs of females with large young show large increases in size. It is calculated that eggs are usually ready for liberation from the ovary at diameters between 3.4 and 4.2 cm or an average of 4.0 cm.

"The ovarian eggs of both immature and mature females undergo a two-year cycle of development. Uterus length and egg size in immature females increase at the same rate. . . .

"The eggs of the dogfish are enclosed shortly after fertilization by a thin horny egg case. Included also within the egg-case and surrounding the yolky egg is a transparent, jelly-like albuminous fluid. The egg case is of shiny, transparent, amber-colored, thin, tough, horny material, roughly cigar shaped. Both ends are drawn out, the anterior one long and tapering off to a fine ribbon, the posterior end short, blunt and flattened. The egg does not extend to the tips of the case, these being filled with a clear colorless jelly material for a distance of about 2 cm. It was observed that when the egg capsules are very fresh the eggs will revolve freely inside the case about the long axis of the egg in such a way as to maintain the embryo always on top when the case is revolved.

"The largest number of eggs found in one capsule was 5. In measurements of 44 eggs removed from capsules the volume of the egg ranged from 21 to 40 cc and averaged 33.9 cc. 5 unbroken perfect egg-capsules were found each containing about 10 cc of albumen but no eggs. The anterior part of the egg-capsule was found in the uteri of 20 dogfish containing large embryos 15-22 cm in length. It is probable that in any particular fish approximately the same amount of capsule and albuminous material is secreted in both oviducts in response to ovarian hormones and independently of the number of eggs in the particular oviduct.

"From a consideration of embryo length and yolk-sac weight it is apparent that nearly all the embryo dogfish at birth will fall between the sizes of 24 and 31 cm. Occasionally an egg of the same generation in the same ovary, or in the same capsule or an embryo in the same fish may be considerably smaller than its neighbours, sometimes only half the volume of the latter. The young of smaller parent fish will on the average be smaller at birth than the young of larger parent fish.

"In addition to the material contained in the original egg-capsule the *Squalus* embryo obtains additional maerial (at least water) from the uterine wall. . . .

"The claspers of the male dogfish remain short, not extending as far as the tip of the pelvic fin, until sexual maturity approaches, when they grow very rapidly and extend beyond the pelvic fin. The clasper lengths of mature and not quite mature male fish overlap so that the length of the claspers cannot be entirely depended on as an index of sexual maturity.

"Below a dogfish length of 71 cm the length and the width of the uterus in immature females remain stable at a very low level. From 71 cm upward the uterus rapidly lengthens and widens in an increasing percentage of immature females but some individuals even as large as 85 cm possessess uteri which have not increased in size beyond the purely immature condition."

Use as Food.—De Kay (1842) asserts that in Scotland the poorer classes have long utilized this species as food, and it may be that it is to *Squalus* that Jessup (1943) alludes, saying:

"It has been a custom among Orkney Islanders for generations to accept dogfish as no more out of the ordinary than eggs and bacon. The method of preparation is a trifle unusual. After cleaning and skinning the fish they break it up and spread the pieces out on the rocks to sun and dry. Even the squeal, so to speak, is put to practical use, the skin being used as sandpaper."

Prince (1904) giving an account of the spiny dogfish in Norway says that this fish when eaten fresh should be skinned before being cooked. Compared with bony fish such as cod the flesh of elasmobranchs such as the dogfish and skate contains very large amounts of urea, not, however, in large enough amount to be at all injurious to the human (Mavor, 1921). Because of this, dogfish must be eaten in a very fresh condition. Mavor (*op. cit.*) says that the flesh of the skate, a close relative of the dogfish, contains when fresh about 2 percent of its total weight of urea as compared with 0.01 percent to 0.03 percent for beef, and quotes a letter received from Dr. A. B. Macallum to the effect that in the dogfish the urea changes to ammonium carbonate when the dogfish stands at ordinary temperatures. The presence of ammonium carbonate together with the odour of the fish makes it exceedingly disagreeable to the taste and smell, and accordingly dogfish used as food must be used soon after caught, or else be frozen and kept frozen in order to prevent transformation of urea into ammonium carbonate.

Field (1910) states, "The Commissioners on Fisheries and Game Massachusetts have personally reported its palatability, the lack of odour or 'strength' and the good consistency when cooked or canned. They say it close-

ly resembles halibut. The spiny dogfish has in recent years been exploited in England as a valuable cheap food. A writer in a London paper states that the Plymouth council engaged an expert cook to prepare dogfish for the table with and without sauce, and that those who partook pronounced it excellent as to colour, flavour and firmness. The dogfishes are not only palatable in the fresh condition, but are as good as many other fishes when preserved by the standard methods. The horned dogfish (*Squalus acanthias*) being in composition most like the salmon is best adapted for canning and is considered as good as the medium grades of salmon. A packer in Petit de Grat, Cape Breton, in 1904 sent me a dozen cans of dogfish he had packed. I passed them round to my friends, who prepared the contents in different ways (fried, scalloped, creamed, etc.). In these forms the canned article was highly praised for flavour and palatibility. Samples were also sent to several hotels where the fish was served to the guests as 'Japanese halibut' and was pronounced most acceptable. An establishment at Halifax has been canning large quantities and putting them on the market labelled 'Ocean Whitefish.' A firm at Charlottetown, Prince Edward Island, has been successful in selling the canned article as 'Sea bass'."

Mavor (*op. cit.*) says "the shape and size of dogfish is such that they can be handled and prepared for shipping fresh or for salting in exactly the same way as cod or haddock. The flesh is as firm or firmer than that of cod or haddock and stands handling well. The shape of a fillet of dogfish which is long, narrow and of nearly uniform thickness for the greater part of its length, is convenient for canning, it being possible to roll the fillet into an ordinary cylindrical can."

In Canada and the United States the name "grayfish" has been adopted as the trade name for dogfish and during the first World War a considerable amount of grayfish was canned in the United States but, apparently owing to the urea present, there was considerable trouble with the cans and the experiment was not a success.

Bigelow and Welsh (1925) say that the dogfish is a far better food when fresh than is generally appreciated and that it would offer a tremendous supply of cheap food if a satisfactory method of canning it were worked out.

Other Uses of Dogfish Flesh.—Dogfish flesh can be made into meal rich in nitrogen or can be used as fertilizer. In this regard Mavor (*op. cit.*) says that the availability of this nitrogen is much reduced if oil is present and hence in the case of the dogfish used as fertilizer the oil ought to be extracted.

In Newfoundland the principal use of dogfish is as winter food for dogs. They are usually split and dried hard, without salting. The presence of a considerable quantity of oil in the flesh apparently prevents attacks by fly larvae and thus it can be dried without salting, which is an important matter when they are used for animal food. Perley (1852) says that dogfish were at that time often dried as food for cattle and that in Nova Scotia and Cape Breton they are dried in great quantities and in the winter fed to pigs which are said to thrive well on them. Dried dogfish has been used for fuel with good results. Dogfish with large embryos inside them contain from 2 to 9 large yellow eggs from one to several times as large as the yolk of a hen's egg. Prince (1904)

says that in Norway the yolk of the eggs of dogfish and skate are used for puddings and other culinary purposes and that they serve as well as fowl's eggs. Mavor (1921) says that the eggs of the dogfish have been found to be a good substitute for hen eggs in the process of tanning.

Dogfish are also sometimes used as fertilizer, being mixed with cod refuse, caplin, kelp and earth or turf.

Liver Oil.—Storer (1867) remarks that the liver oil was of poor quality, becoming hard in cold weather. However, in Good's (1884) time it was eagerly sought by currriers. Templeman (*op. cit.*) examined 285 samples of oil from the livers of individual dogfish. His findings were as follows:

"Two hundred and eighty-five samples of oil from the livers of individual dogfish were examined for their Vitamin A values.

"Immature males possess the lowest Vitamin A values, all 7 samples examined being below 2000 U.S.P. units per gram. The immature females are larger and range somewhat higher in Vitamin A value but 86 percent are below 2000 U.S.P. units. In the mature males 80 percent are below 2000 U.S.P. units, 91 percent below 3000 U.S.P. units and 93 percent below 5000 units, while the corresponding percentages for pregnant females 75 to 84 cm are 69, 86 and 94 percent and for pregnant females 85 to 101 cm are 42, 65 and 84 percent.

"In pregnant females the Vitamin A value increases greatly with an increase in size from 1848 U.S.P. units per gram at 75-79 cm to 3797 U.S.P. units at 90-99 cm. In mature males and immature females in view of the relatively small number of samples examined and the wide variation in individual Vitamin A values, the small increases in Vitamin A content with size were of no statistical significance. Possibly in some cases because of too few samples there are no statistical differences in Vitamin A value in the same size groups between immature males, mature males and immature females, between mature males and pregnant females, nor between females with tiny embryos and females with large embryos. There is in one out of two size groups a statistically significant difference in the Vitamin A values of immature females and of pregnant females.

"The oil from dark grey livers possesses a considerably higher Vitamin A value than the oil from light-coloured livers. The differences in the means of the Vitamin A values of the above liver colours are statistically significant in each size group.

"Vitamin A value is inversely related to the oil yield.

"Light coloured livers are heavier in the same size group and yield more oil than darker coloured livers.

"In the same size sex and maturity group when the liver weight is low, the oil yield and oil expressed as a percentage of liver weight are low, the weight of the dogfish is low, the Vitamin A value is considerably higher and the liver is darker in colour, while the reverse is true when the liver weight is high. The Vitamin A value of the oil is affected both by the oil yield and by the size or age. It is possible that the mere fact of pregnancy may not increase the Vita-

min A value except in so far as pregnancy reduces the amount of oil in the liver without corresponding reduction of the Vitamin A present. Pregnant females yield less oil than immature females of the same size group.

"It is concluded that under the present Canadian schedule of dogfish oil prices it is unlikely that the Atlantic dogfish can be actively fished for its liver oil alone. The present practice of expressing oil yield as a percentage of liver weight is at fault since it increases the apparent yield of lean livers. It would be preferable to calculate oil yield as a percentage of the total weight of the fish. It is probable that in the mature female dogfish in eastern North American waters as in other fish the yield of oil is low during the winter and spring spawning period since it is preceded by a great increase in egg volume in the ovaries of mature females.

"A discussion is given of residual oil in dogfish livers and of methods of extraction of oils of high Vitamin potency, also of the reported uses of dogfish liver oil.

"It is concluded that the Atlantic dogfish could be commercially utilized, only if the liver were utilized for its oil and the body ground into meal in fish meal plants which normally utilize other fishes as well as dogfish. The highly migratory nature of the dogfish could be utilized to concentrate the commercial catch of dogfish in a relatively few headland localities."

RHINA DUMERIL (Le Sueur)—Angel shark, Monkfish

Range.—Atlantic coast of the United States south to Jamaica.

Occurrence in Texas.—Three specimens of this odd fish have been caught in shrimp trawls off Port Aransas. On December 30, 1945, a female was caught, while on January 24, 1946, a male was obtained in the same locality. Slightly later a second female was brought in by another fisherman.

Two other specimens of this shark have been obtained in the same locality. The first was noted by Parks (1939) as *Squatina squatina.* He gives no data in his paper on the locality where it was obtained, but in a letter to Dr. Gordon Gunter, he stated that it was obtained in a trawl in Corpus Christi Bay in March, 1937. Another specimen was taken in 1929, about 5 miles offshore from Port Aransas, and is now in the shop of Roberts and Brundrett, taxidermists, at that place. This is the first specimen known from the Texas coast, and the second one recorded, according to Gunter (1941) who listed it as *Squatina squatina.*

SYNOPSIS OF DIAGNOSTIC CHARACTERISTICS OF GENERA OF SHARKS KNOWN FROM THE GULF OF MEXICO, PARTICULARLY THOSE MENTIONED IN THIS NOTE, WITH KEYS FOR CARCHARINUS AND SPHYRNA

The identification of sharks has been considered difficult because many of the species are similar to one another in general form and look alike on superficial examination. The color of sharks is not often important as a means of identification but attention to the relative size, shape, and position of the fins, of the eyes, of the nostrils, and of the mouth may be important. The size and

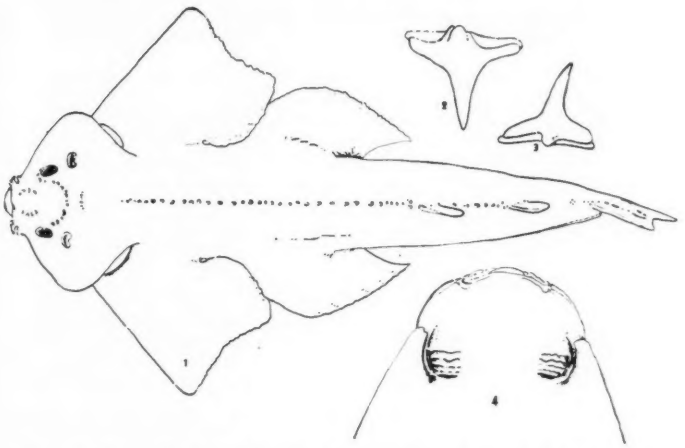

Plate 19. Figs. 1-4. *Rhina dumeril.*—1. *Rhina dumeril* (from *Sharks of the Caribbean*); 2. Upper fifth tooth (from *Sharks of the Caribbean*); 3. Lower fifth tooth (from *Sharks of the Caribbean*); 4. Ventral view (from *Sharks of the Caribbean*).

shape of the teeth are very important in identification of species but other features must receive consideration to avoid confusion. Finally the adult size is a very useful characteristic for identification. A shark eight feet long for example, cannot be *Scoliodon,* because *Scoliodon* reaches a length of only a little more than 3 feet. Male sharks before maturity have small claspers which do not reach appreciably beyond the tips of the pelvic fins, but when sexual maturity is reached the claspers develop at a relatively greater rate and extend well beyond the fin tips. Therefore the presence of fully developed claspers in a shark three feet long is an indication that the shark belongs to one of the small species. It cannot, for example be *Carcharinus leucas* because that form does not reach maturity until it is 7 feet or more in length. The maturity of females is more difficult to determine and dissection is necessary to demonstrate the presence of mature ova or of embryos. New-born sharks show a prominent scar on the ventral surface between the pectoral fins where the yolk-sac or yolk-sac placenta was attached. This scar disappears quickly with growth. Consequently, this scar, when present, indicates that the shark is very young.

Only two of the fifteen genera of sharks known to be present in Texas waters are represented there by more than one species. It is hoped that the following synopsis of the generic characteristics along with the keys to the species of hammerheads and ground sharks will serve for the identification of most specimens.

SYNOPSIS OF GENERA OF SHARKS KNOWN FROM THE GULF OF MEXICO, PARTICULARLY THOSE MENTIONED IN THIS NOTE

1. Sharks with nasal cirri (cylindrical fleshy "feelers" over an inch long in adult sharks) located just in advance of the corners of the mouth.
Ginglymostoma cirratum, the nurse shark. A big headed species with a small mouth and heavy (for crushing) jaws. Skin heavily armored with denticles but these without sharp points as in most other sharks. The nurse shark is mature at 5 feet or less but may reach a length of 11 or 12.

2. Sharks with much flattened and expanded heads.
Sphyrna, the hammerheads and shovel-nosed sharks. There are four species recorded from Texas, see Key B.

3. Sharks with terminal mouth, that is, with the mouth opening located at the extreme forward end of the shark, mouth not located below a more or less extended snout.
Rhincodon typicus, the whale shark. A gigantic offshore species which feeds on plankton. Individuals as long as 40 feet have been taken. There are several heavy ridges in the skin and the dark color of the shark along with its small white spots arranged in rows may give the shark the appearance of riveted armor plate.

4. Sharks with the upper lobe of the tail prolonged so that its length is approximately one-half the total length of the shark.
Alopias vulpinus, a relatively large shark with a small mouth and large eyes. Reaches a total length of at least 12 feet.

5. Flattened ray-like sharks with no anal fin. This form combines the characteristics of the sharks and the rays. The pectoral fins are not attached to the body at the anterior end, a feature which makes these fins have some resemblance to the conventional angel wing.
Squatina dumeril, a small form, adults may reach a length of 4 feet.

6. Sharks of normal fusiform shape but no anal fin, both dorsal fins armed with a strong spine.
Squalus acanthias, a small species, matures at about 3 feet long.

7. Sharks with conical heads and pointed snouts, extremely small second dorsal fin, and base of tail flattened and greatly reinforced by lateral keels (expansions of connective tissue and skin). The upper lobe of the tail is only slightly larger and stronger than the lower lobe and the tail is shaped somewhat like the tail of a mackerel. Teeth long, narrow and pointed, awl like, with more than one functional series, obviously better for puncturing, tearing, or holding than for cutting.
Isurus oxyrinchus, Mako. An offshore form reaching a length of 8 or 10 feet.

8. Sharks with characteristics as in *Isurus* except that the teeth are in one functional series normally with those of the upper jaw triangular, flattened and strongly serrate on the edges. The lower jaw teeth are narrower but somewhat flattened and definitely serrate, good cutting or sawing teeth.
Carcharodon carcharias, the great white shark, man eater. Adults are 14 feet 6 inches to more than 18 feet long. They may be, or appear to be, black in life, or white, or any intermediate shade. Large ones occasionally show a disposition to attack boats and it is unwise to harpoon them except from a sturdy boat of adequate size.

The preceding genera all have some outstanding or unique characteristics by which they may be recognized readily. The following genera are the ground sharks or typical sharks and identification usually requires more attention to detail.

9. Sharks with blunt teeth arranged in pavement. A spiracle present.
Mustelus canis, smooth dogshark. A small shark not often reaching a length as great as 4 feet.

10. Sharks with large strongly serrate teeth obviously good for cutting or sawing. The teeth of the upper jaw and lower jaw just alike. The snout is short and blunt. There is a spiracle.

Galeocerdo cuvier, tiger shark. A large shark reaching maturity at about 9 feet 6 inches and commonly as much as 12 feet long. The young are spotted but the spots coalesce to form faint bars as the shark grows older and may entirely disappear in old specimens.

11. Sharks with narrow awl shaped teeth in both jaws, no spiracle, a blunt short snout, the second dorsal fin nearly as large as the first dorsal fin. None of the teeth are serrate in the strict sense of the word. The bases of the upper jaw teeth may have wavy edges with fine notches but there are no toothlets produced by evenly spaced notches.

Negaprion brevirostris, lemon shark. Mature lemon sharks are from 7 feet 5 inches to 11 feet long.

12. Sharks with readily discernible labial folds (grooves in the skin extending from the corner of the mouth along the jaw). The extent of the labial folds is somewhat variable but the Texas form has the outer labial fold (along the upper jaw) usually about as long as the diameter of the eye.

Scoliodon terra-novae, puppy shark. A small species mature at about 3 feet long. Teeth sharp with point directed toward the angle of the jaws.

13. Sharks with labial folds reduced or wanting, teeth awl shaped and not serrate in either jaw, snout moderately long and pointed, second dorsal fin small, gill slits long, the length of the first gills slit as long or longer than the distance between the nostrils.

Aprionodon isodon, smooth tooth shark. A small species, mature at less than 4 feet long.

14. Sharks with shorter gill slits, the length of the first gill slit not greater than the distance between the nostrils. Labial folds reduced or absent. No spiracle. Snout either short or long. Teeth of the upper jaw serrate (serration may only be visible with a magnifying glass on some forms and is sometimes difficult to detect in young sharks). The teeth of the upper and lower jaws typically somewhat different. The upper jaw teeth are broader and better adapted to holding or piercing.

Carcharhinus, ground sharks. For identification of species of *Carcharhinus* see Key A.

15. Sharks with the characteristics of Carcharhinus as given here but little known and traditionally placed in a separate genus. An offshore species (possibly a compound) with a very long snout and the teeth of the upper jaw not notched or constricted at the base but the tips slightly inclined toward the angles of the jaws.

Prionace glauca, the blue shark. The species is reliably reported to reach a very large size although adults less than 10 feet long have been taken in the North Atlantic and the young of this form are quite small at birth.

KEY A. TEXAS SPECIES OF CARCHARHINUS AND EULAMIA

A—Sharks without a trace of a ridge in the skin between the two dorsal fins.

B—Sharks with teeth of both upper and lower jaws narrow and erect, awl like. Tips of some or all of the fins black.

C—Sharks with teeth of the lower jaw free from serration, the cusps straight and not recurved outward at the tip. Medium size sharks mature at about 6 feet long and reaching a length of 8 feet .....*Carcharhinus maculipinnis*. The great black-tip.

CC—Sharks with the teeth of the lower jaw finely serrate, the cusps somewhat sinuous, the points slightly cuved outward.

D—Snout narrowed at the nostrils so that the outline of the head viewed from above has a perceptible angle at the nostrils. Size of the adults probably the same as in DD .....*Carcharhinus natator*. Texas black-tip.

DD—Snout not abruptly narrowed at the nostrils, outline of the head a smooth curve. Adults 4 feet to 6 feet long ..... *Carcharhinus limbatus*. Black-tip.

BB—Sharks with the upper jaw teeth unlike the lower jaw teeth, the upper jaw teeth broad, somewhat triangular, and serrate. Lower jaw teeth narrow, awl shaped.

E—Small sharks, adults 3 to 4 feet long, with teeth of the upper jaw notched on the outer margin and points of cusps directed toward the angles of the jaws. No black-tips on the fins. Snout moderately pointed.

F—A black smudge on the tip of the nose, prominent in young, indistinct in adult specimens. Anal fin usually not in advance of second dorsal ..... *Carcharhinus acronotus*. Black-nosed shark.

FF—No black smudge on the tip of the nose. Origin of anal usually in advance of origin of second dorsal ..... *Carcharhinus porosus*.

EE—Large sharks, adults 7 to 10 feet long with heavy heads and blunt, rather short snouts. Teeth near the center of the upper jaw flattened, almost triangular, not notched on the outer margin. Young over 2 feet long at birth ..... *Carcharhinus leucas*. Bull shark.

AA—Sharks with a ridge in the skin extending for at least a fourth of the distance between the first and second dorsal fins.

G—Teeth in about 25/25 rows. Size not known but probably large ..... *Eulamia springeri*.

GG—Teeth in 30/29 to 32/30 rows.

H—A medium size species, adults 6 feet to 7 feet 8 inches long. Young over 24 inches long at birth, dorsal fin high, its origin in advance of the free inner angle of the pectoral fin ..... *Eulamia milberti*. Sand-bar shark.

HH—A large species, adults 9 feet 4 inches to 11 feet 10 inches long. Young over 36 inches long at birth. First dorsal fin not very high, its origin in back of the angle of the free inner point of the pectoral fin ..... *Eulamia obscurus*. Dusky shark.

KEY B. TEXAS SPECIES OF SPHYRNA, THE HAMMERHEADS AND SHOVEL-NOSE SHARKS

A—Expanded head spade shaped, the front margin not scalloped or lobed. Teeth of the outer three or four rows in the lower jaw without cusps. Small sharks, adults 3 to 4 feet long ..... *Sphyrna tiburo*. Shovel-nose.

AA—Expanded head hammer shaped, its front margin lobed.

B—Front margin of the head three lobed. No trace of an indentation at the middle of the front margin of the head. Teeth serrate. A large species. Adults 12 feet long are recorded ..... *Sphyrna zygaena*. Northern hammerhead.

BB—Front margin of the head with four lobes between the nasal notches. An indentation in the middle of the front margin of the head.

C—Second dorsal fin with a long posterior lobe, the fin low. Posterior lobe when lifted upward reaching a height twice as great as the height of the second dorsal. Teeth smooth without trace of serration. A medium size shark mature at around 7 feet long and reaching a length of more than 10 feet ..... *Sphyrna diplana*. Southern hammerhead.

CC—Second dorsal fin with a short posterior lobe, the fin high. The posterior lobe when lifted upward reaching a height about equal to the height of the second dorsal. Teeth serrate. A very large shark, mature at about 10 feet long and reaching a length of at least 14 feet 10 inches ..... *Sphyrna tudes*. Great hammerhead.

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Studies on North American Chiggers. No. 3. The Subgenus Neotrombicula*

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CONTENTS

Introduction 153
Materials and methods 153
Systematics 154
Key to groups 156
"Bisignata" group 156
Key to species 157
Trombicula (Neotrombicula) bisignata Ewing 157
Trombicula (Neotrombicula) subsignata n. sp. 159
Trombicula (Neotrombicula) eusignata n. sp. 161
"Microti" group 162
Key to species 162
Trombicula (Noetrombicula) microti Ewing 164
Trombicula (Noetrombicula) californica Ewing 169
Trombicula (Noetrombicula) harperi Ewing 170
Trombicula (Noetrombicula) cavicola Ewing 172
Trombicula (Noetrombicula) rohweri Ewing 174
Trombicula (Noetrombicula) whartoni Ewing 175
Trombicula (Noetrombicula) lipovskyi n. sp. 177
Trombicula (Noetrombicula) alaskensis n. sp. 178
Trombicula (Noetrombicula) browni n. sp. 178
Trombicula (Noetrombicula) dinehartae n. sp. 179
Trombicula (Noetrombicula) goodpasteri n. sp. 180
Trombicula (Neotrombicula) jewetti n. sp. 182
Trombicula (Noetrombicula) richmondi n. sp. 183
Ungrouped species 184
Key to species 184
Trombicula (Neotrombicula) carterae n. sp. 184
Trombicula (Neotrombicula) farrelli n. sp. 185
Trombicula (Neotrombicula) sylvilagi n. sp. 186
Trombicula (Neotrombicula) varians n. sp. 188
Trombicula (Neotrombicula) waynensis n. sp. 188
Distribution 190
Table I. — Summarized geographic and seasonal distribution of N. A. species of *Neotrombicula* 191
Table II. — Classified list of hosts and the species of *Neotrombicula* recorded from them 191
References 193

Introduction

The most common chiggers of the genus *Trombicula* that parasitize small mammals in North America are all more or less related. The present paper is concerned with their systematics, geographic distribuiton, seasonal occurrence, and host relationships.

Materials and Methods

Specimens of trombiculids from small mammals have been collected extensively in recent years in connection with many projects. Of particular importance are the collections of the Public Health Service's Rocky Mountain

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Laboratory, the Pennsylvania Game Commission's Mammal Survey under the direction of J. Kenneth Doutt, the U. S. Department of Agriculture, Francis Harper, E. W. Jameson, the University of Kansas made by L. J. Lipovsky, and Duke University. The specimens studied in preparing this paper have come largely from the collections just mentioned, but much material in the U. S. National Museum has been consulted in an attempt to bring the older viewpoints on specific identification into harmony with the changes in concepts stimulated by the vast influx of material in recent years. The identification of the hosts have been supplied by the collectors in most cases. Specimens of hosts collected by personnel at Duke University were identified by the U. S. National Museum. Access to the manuscript by C. B. Philip and H. S. Fuller was obtained through the courtesy of the authors.

All of the specimens received have been studied in detail. The results are to be found in the section on systematics. Host, locality, and dates for each collection are recorded for all specimens. These data form the basis for the discussion of distribution. For the convenience of future workers, specimens will be sent to various collections. A key to the collections in which material will be deposited follows:

U.S.N.M.—U. S. National Museum
R.M.L.—Rocky Mountain Laboratory
D.U.—Duke University
B.M.—British Museum (Natural History)
S.A.M.—South Australian Museum Adelaide
C.M.—Carnegie Museum of Pittsburgh
K.U.—Kansas University
H.S.F.—Personal collection of H. S. Fuller
A.H.—Personal collection of Anita Hoffman

Wharton (1948) found that a careful study of the chaetotaxy of the legs facilitates the description, recognition, and classification of trombiculid larvae. He therefore proposed, for the specialized nude setae of the appendages, the following names which are here re-defined:

genuala—sensory seta on the genu.
microgenuala—microsensory seta on the genu.
tibiala—sensory seta on the tibia.
microtibiala—microsensory seta on the tibia.
spur—blunt, striated, sensory seta on the tarsus.
microspur—microsensory seta associated with the spur.
subterminala—long seta on the tip of the tarsus.
parasubterminala—smaller seta associated with the subterminala.
pretarsala—sensory seta on the pretarsus.
mastifemorala—long whip-like seta on the telofemur.
mastitibiala—long whip-like seta on the tibia.
mastitarsala—long whip-like seta on the tarsus.

The number and distribution of these specialized setae have been used extensively in the keys. Their form and relative position are illustrated in figure 1.

SYSTEMATICS

NEOTROMBICULA Hirst, 1925

Type: *Acarus autumnalis* Shaw, 1790

1925 *Neotrombicula* Hirst: p. 609; 1929a *Neotrombicula* Hirst: Ewing, p. 23; 1946 *Neotrombicula* Hirst: Ewing, p. 437; 1950 *Neotrombicula* Hirst: Philip and Fuller.

Within the genus *Trombicula* are two groups of larvae which, despite the fact that they are morphologically quite similar, give rise to very different nymphs and adults. One of these is here recognized as the subgenus *Neotrombicula* Hirst, 1925. Philip and Fuller, while suggesting the need for

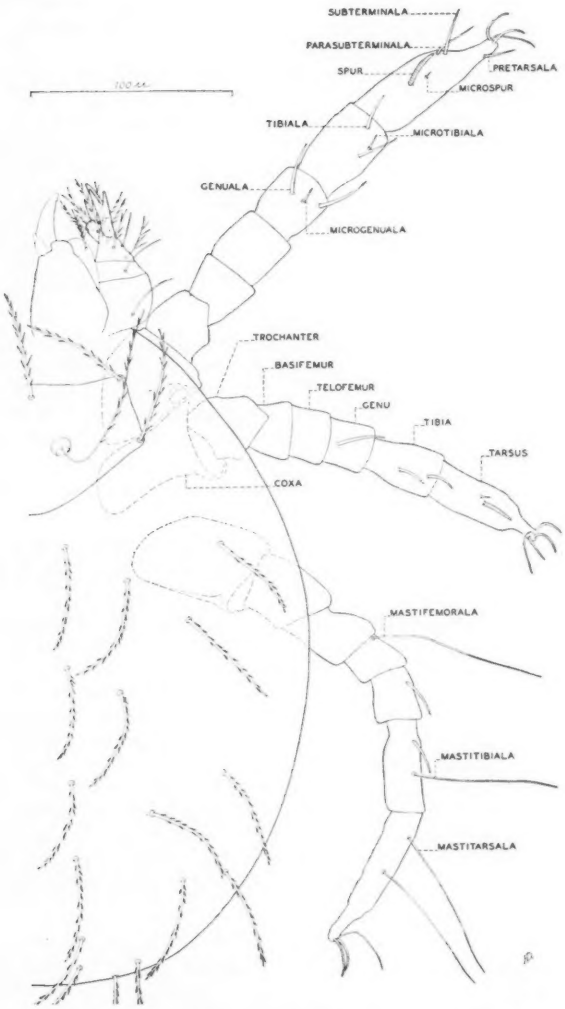


Fig. 1.—*Trombicula microti* with the sensory setae of the legs. Other setae of the legs omitted.

eventually reviving *Neotrombicula*, have discussed this group in part as the "autumnalis" group. The other group was erected as the subgenus *Trägårdhula* by Berlese, 1912 (= *Pentagonella* Thor, 1936 = *Megatrombicula* Michener, 1946). These two subgenera may be separated as follows:

Larvae with subequal plumose setae on the proximal segments of leg III usually parasitic on water-birds; adults with eyes ..... *Trägårdhula*

Larvae with whiplike or long plumose setae on the proximal segments of leg III, usually parasitic on terrestrial animals, especially small mammals; adults without eyes ..... *Neotrombicula*

For purposes of this paper a further character is available for separating the 2 subgenera since the larvae of North American species of *Neotrombicula* have 2 or 3 mastitarsalae on leg III while the larvae of all species of *Trägårdhula* have only 1. It should be added that new world species of *Trägårdhula* have not been recorded north of Panama.

Neotrombicula is herein understood to include all species of *Trombicula* of which the larvae usually have a more or less pentagonal scutum, 3 plumose setae on the distal margin of telofemur III and invariably have 1 or more mastitarsalae on leg III, and develop into nymphs and adults which lack eyes. The following key will separate the species into 4 groups, 3 of which occur in North America:

KEY TO GROUPS

1. One mastitarsala III ..... "autumnalis" group (Old World) not of Philip and Fuller
   Two or more mastitarsalae III 2
2. One mastifemorala III, one mastitibiala III and two mastitarsalae III .... "microti" group
   Not as above 3
3. No mastifemorala III, one mastitibiala III, three mastifemoralae III.... "bisignata" group
   Not as above ..... ungrouped species

Twenty-one species of *Neotrombicula* from North America are recognized here. Three belong to the "bisignata" group, 13 belong to the "microti" group, and 5 are so diverse as to be considered as ungrouped species. Each group is discussed in a separate section of the paper and keys to the different species within each group are given. In order to avoid repetition complete descriptions of only *Trombicula bisignata* and *Trombicula microti* are given. All of these are based on the information given in the complete descriptions and only the points in which the species differ are discussed. Since none of the "autumnalis" group is known to occur in North America this group is omitted.

"BISIGNATA" group

The "bisignata" group includes 6 or possibly 7 species of *Neotrombicula* that are characterized by having 1 mastitibiala III, and 3 mastitarsalae III. Two of the species are found in the Far East, 1 is found in South America, 3 are found in the United States, while the seventh is from Europe. The European representative *T. fahrenholzi* is only tentatively assigned to the group

since the distal segments of all of the legs of the single specimen known are missing.

KEY TO SPECIES

1. Three genualae I ..... *T. f.* Philip and Fuller
   Two genualae I 2
2. Nude seta on palpal genu 3
   Branched seta on palpal genu 4
3. Nude seta on palpal femur ..... *T. eusignata* n. sp.
   Branched seta on palpal femur ..... *T. subsignata* n. sp.
4. Dorsal seta on palpal tibia nude 5
   Dorsal seta on palpal tibia not nude 6
5. Nude lateral seta on palpal tibia ..... *T. fahrenholzi* (Oudemans, 1910)
   Feathered lateral seta on palpal tibia ..... *T. shannoni* Ewing, 1929
6. Galeal seta feathered ..... *T. t.* Philip and Fuller
   Galeal seta nude ..... *T. bisignata* Ewing, 1929

TROMBICULA (NEOTROMBICULA) BISIGNATA Ewing, 1929

Plate I, Map 1

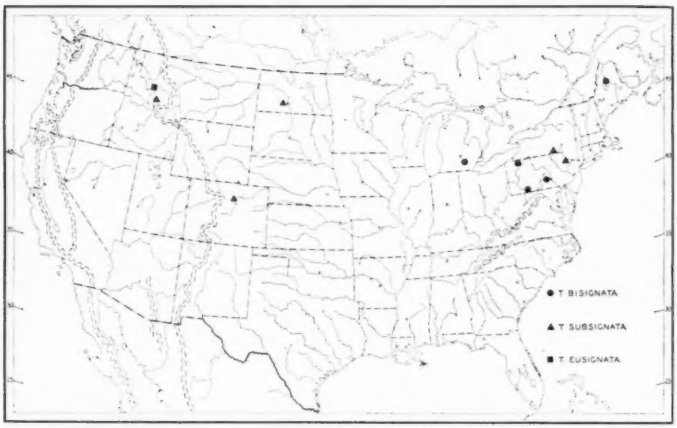
1929b *Trombicula bisignata* Ewing (in part): p. 295; 1931 *Trombicula bisignata* Ewing: p. 7; 1937 *Trombicula bisignata* Ewing: p. 170; 1942 *Trombicula bisignata* Ewing: Radford, p. 57; 1947 *Trombicula bisignata* Ewing: Thor and Willmann, p. 270; 1950 *Trombicula bisignata* Ewing: Philip and Fuller.

Body.—Color in life, red. Striae well developed. Eyes 2 plus 2 on a poorly defined ocular plate; anterior eye 8 microns in diameter, posterior eye 7 microns in diameter. Anus situated at the level of the sixth row of ventral setae.

Gnathosoma.—Chelicerae with a punctate, angular basal segment and a typical blade-like distal segment. Palpal coxa with a feathered seta; palpal femur rounded laterally and with a feathered seta; palpal genu with a branched seta; palpal tibia with a forked dorsal seta, a nude (specimen 175-2 and 175-3 have a forked seta on one side) lateral seta, a ventral branched seta, and a trifurcate palpal claw with the median prong largest; palpal tarsus with a basal spur, 6 feathered ventral setae in 2 rows of 3 each, 1 larger dosal feathered seta, and a subterminala. Galeal seta nude.

Legs.—All coxae with a single feathered seta. All femora divided so that all legs have 7 segments. Sensory setae distributed as follows: Leg I with a pair of genualae with a microgenuala between them, 2 tibialae in tandem with a microtibiala between and posterior to them, a relatively short spur, a microspur anterior to the spur about half the length of the spur from its base, a subterminala with a parasubterminala equal to half the length of the subterminala, and a pretersala; leg II with a single genuala, 2 tibialae in tandem, a spur with a microspur just proximal to the spur (specimen 175-1 has 2 spurs and 1 microspur on the left side), and a pretarsala; leg III with 1 genuala, 1 tibiala with a mastitibiala just distal to it, 3 mastitarsalae (a basal pair and a more distal one form a triangular pattern on the proximal half of tarsus III). All legs with paired claws flanking a median, thinner, claw-like empodium.

Scutum.—The scutum is roughly pentagonal in shape and is ornamented with scattered punctae. The sensillary bases are widely separated and each has



Map 1.—Distribution of *T. bisignata, T. subsignata,* and *T. eusignata.*

a fold posterior to it. The sensillae are barbed along their distal four-fifths; the proximal barbs are minute, but those on the distal half are fairly large. There are only about 6 barbs on each sensilla. The scutal setae are provided with short barbs along their entire length. The Standard Data (Womersley and Heaslip 1943) follow:

	AW	PW	SB	ASB	PSB	AP	AM	AL	PL	S
Type specimen	67	88	29	29	28	26	46	42	62	72
GWW No. 15	65	84	28	28	28	28	48	41	58	79

AW and PW measurements were made on 10 other specimens as follows:

AW	62	65	66	65	69	69	65	68	68	68	
PW	87	83	86	84	84	88	84	83	87	83	
Total	149	148	152	149	153	157	149	151	155	151	Average 151

Setae.—The dorsal setae are similar to the scutal setae but have longer barbs. The humeral setae are about 55 microns long while the more posterior setae are about 50. The dorsal setae are arranged in rows approximately as follows: 2-8-6-6-4-4. In the type, however, they are 2-8-1-6-2-6-6-4, while in specimen 15 they are 2-8-6-7-4-4. Of 18 specimens studied 15 had the first 2 rows 2-8, the other 3 were 2-7. The ventral setae are arranged 2-2 plus 33 or 34 in irregular rows posterior to the sternal setae. The sternal setae are about 40 microns while the ventral setae are about 33.

Material studied.—Type U.S.N.M. No. 992.

Host	Locality	Date	Collection	No. specimens
Microtus pennsylvanicus	Mt. Katahdin, Me.	22 Aug. 1928	U.S.N.M.	Type+2
Passerherbulus henslowi	Livingston Co., Mich.	1-11 Aug. 1933	U.S.N.M.	6
Condylura cristata	Perry Co., Pa.	27 July 1947	R.M.L.	1
Microtus pennsylvanicus	Somerset Co., Pa.	22 Aug. 1947	R.M.L.	2
			D.U.	1
Tamiasciurus hudsonicus	Somerset Co., Pa.	27 Aug. 1947	D.U.	1
Ondatra zibethica	Somerset Co., Pa.	29 Aug. 1947	C.M.	3
Ondatra zibethica	Somerset Co., Pa.	8 Sept. 1947	R.M.L.	1

Diagnosis.—*T. bisignata* is the only species of the "bisignata" group that has a branched seta on the palpal genu and a forked dorsal and nude lateral seta on the palpal tibia.

Remarks.—*T. bisignata* is not a common parasite, but it is present on a wide variety of hosts. Its known distribution is sporadic, but its occurrence in southern Pennsylvania, Michigan, and Maine suggests a wide range.

Ewing, 1929b, refers 2 specimens from *Peromyscus maniculatus abietorum* taken 22 August 1928 by W. J. Hamilton, Jr. at Mt. Desert Island, Maine, to *T. bisignata*, but these do not have the characteristics of the "bisignata" group. Type slide No. 992 in the collection of Acarina in the U. S. National Museum has 3 specimens on it. The specimen on the right is here designated as the lectotype of *T. bisignata*.

Trombicula (Neotrombicula) subsignata n. sp.

Fig. 2, Map 1

This species, of which 27 specimens have been examined, is extremely close to *T. bisignata* and may indeed be a subspecies or only a variant.

Gnathosoma.—The structures of the gnathosoma in the present form and in *T. bisignata* are much alike except for the setae on the palps. While the seta on the palpal femur of *T. bisignata* is feathered, that of *T. subsignata* has fewer barbs and can be more properly designated as branched. The seta of the palpal genu in *T. subsignata* is nude (in one specimen the genual seta on one palp has two branches), while in *T. bisignata* it is branched. The dorsal seta on the palpal tibia in *T. subsignata* is forked as in *T. bisignata* in 9 out of 54 cases, usually, however, it is nude.

Scutum.—The Standard Data for the type of *T. subsignata* follow:

AW 65, PW 86, SB 28, ASB 28, PSB 26, AP 28, AM 48, AL 46, PL 58, and S 77.
The AW and PW measurements of 20 specimens were as follows:

AW	65	69	68	68	72	69	76	68	69	69	72	73	73	69	70
PW	86	88	87	84	90	92	99	87	88	86	91	90	91	88	94
Total	151	157	155	152	162	161	175	155	157	155	163	163	164	157	164
AW	69	70	72	68	66										
PW	88	94	92	87	90										
Total	157	164	164	155	156	Average: 159.									

The mean of AW and PW for the 10 specimens of *T. bisignata* is 151 and that of the 20 specimens of *T. subsignata* is 159. The t value for the difference between the means is 4, indicating that there is a significant difference between the two groups of specimens. On the other hand, 4 specimens from Montana of *T. subsignata* average 149 microns for AW plus PW. Thus the average for *T. bisignata* falls between the extremes of *T. subsignata*. This discussion has been included to demonstrate the relative unimportance of using Standard Data for the separation of closely related species.

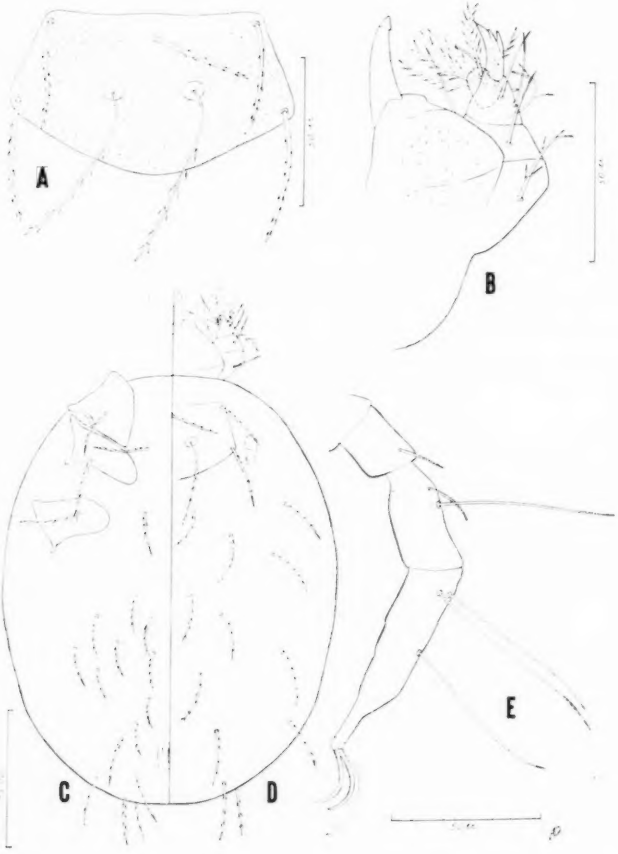


Fig. 2.—*Trombicula subsignata*. A. scutum, B. dorsal view of gnathosoma, C. venter, D. dorsum, and E. distal segments of leg III showing sensory setae.

Setae.—In *T. bisignata* the first row of posthumeral dorsal setae contains 8 setae in 15 out of 18 specimens. In *T. subsignata* on the other hand, 24 out of 27 specimens have 6 setae in this row. The remainder of the specimens studied in both *T. bisignata* and *T. subsignata* have 7 setae in the first posthumeral row.

Material studied.—Type U.S.N.M. No. 1837.

Host	Locality	Date	Collection	No. specimens
Marmota flaviventer	Ravalli Co., Mont.	12 June 1945	D.U.	2
Citellus lateralis	Ravalli Co., Mont.	9 July 1945	R.M.L.	2
Seiurus motacilla	Wayne Co., Pa.	2 Aug. 1946	R.M.L.	1
			S.A.M.	1
Zapus hudsonius	Broome Co., N. Y.	23 July 1947	S.A.M.	1
Zapus hudsonius	Broome Co., N. Y.	10 Aug. 1947	B.M.	2
			C.M.	1
Microtus pennsylvanicus	Broome Co., N. Y.	10 Aug. 1947	U.S.N.M.	Type+4
			R.M.L.	2
			D.U.	2
			H.S.F.	2
			K.U.	1
			A.H.	2
Microtus pennsylvanicus	Warren Co., Pa.	23 Sept. 1947	C.M.	1
Citellus lateralis	Boulder Co., Colo.	13 Aug. 1947	K.U.	1
Sylvilagus floridanus	Morton Co., N. D.	22 Aug. 1948	R.M.L.	1

Diagnosis.—*T. subsignata* can be distinguished from the other members of the group in having a feathered seta on the palpal femur and a nude seta on the palpal genu.

Remarks.—*T. subsignata* is known from southern New York, northern Pennsylvania, north-central Colorado, south-central North Dakota and western Montana. Since *T. bisignata* has not been collected in these regions, there is a possibility that *T. subsignata* may be only a geographical race or subspecies of *T. bisignata.* However, there is no question concerning the morphological difference between the two forms, therefore it appears to be more reasonable to assign each to specific rank.

Trombicula (Neotrombicula) eusignata n. sp.

Fig. 3, Map 1

T. eusignata differs from the other two North American species of the group as follows:

Gnathosoma.—Palpal setae on the femur, genu, and dorsal and lateral aspects of the tibia nude. No variation was observed in the 4 specimens examined. In other respects the gnathosoma is like *T. bisignata* and *T. subsignata.*

Scutum.—Ornamentation of the scutum is not as heavy as in *T. subsignata.* Standard Data:

AW	PW	SB	ASB	PSB	AP	AM	AL	PL	S
61	76	26	23	27	25	36	34	40	56
59	79	28	21	27	24	37	37	40	53
61	78	28	25	26	24	37	37	38	58
65	77	27	21	24	23	—	—	37	65

The AW and PW for this series average 139 microns, thus indicating a narrower scutum than those found in either *T. subsignata* or *T. bisignata.*

Setae.—Dorsal setae are arranged according to the following formula: 2-6-6-4-2 or 2-6-6-4-2-2. The ventral setae are arranged: 2-2 plus about 26 posterior to the sternals. No variation in the number of setae in the first post-humeral row of dorsal setae was observed.

Material studied.—Type R.M.L. No. 21943 holotype.

Host	Locality	Date	Collection	No. specimens
Eutamias amoenus	Missoula Co., Mont.	11 Aug. 1945	R.M.L.	Type+1
			D.U.	1
Citellus lateralis	Missoula Co., Mont.	11 Aug. 1945	R.M.L.	1

Diagnosis.—*T. eusignata* is the only member of the group with a nude seta on the palpal femur.

"MICROTI" group

The "microti" group is represented by 13 closely related species all of which are to be found in North America. Its distinguishing characteristics are a mastifemorala III, a mastitibiala III, and 2 mastitarsalae III. *T. microti* will be used as a standard for the description of the group and the other species will be compared with it.

KEY TO SPECIES

1. Sensillae branched, at least with minute basal barbs 2
   Sensillae nude 10
2. Seta on palpal femur nude 3
   Seta on palpal femur branched or feathered 5
3. Sensillae with basal barbs only ..... *T. browni sp.*
   Sensilla with barbs along entire length 4
4. Galeal seta feathered ..... *T. microti* Ewing
   Galeal seta nude ..... *T. harperi* Ewing
5. Galeal seta feathered ..... *T. jewetti* n. sp.
   Galeal seta nude 6
6. More than 2 humeral setae ..... *T. goodpasteri* n. sp.
   Only 2 humeral setae 7
7. One genuala I ..... *T. richmondi* n. sp.
   Two genualae I 8
8. Dorsal setae 50 or more ..... *T. alaskensis* n. sp.
   Dorsal setae 30 or less 9
9. Scutual punctae few and scattered; sensillae with basal barbs only .... *T. whartoni* Ewing
   Scutual punctae numerous and evenly distributed; sensillae with barbs along entire length ..... *T. lipovskyi* n. sp.

10. Three genualae I ..... *T. dinehartae* n. sp.
Two genualae I 11
11. Seta on palpal genu nude ..... *T. californica* Ewing
Seta on palpal genu branched or feathered 12
12. Galeal seta nude ..... *T. rohweri* Ewing
Galeal seta feathered ..... *T. cavicola* Ewing

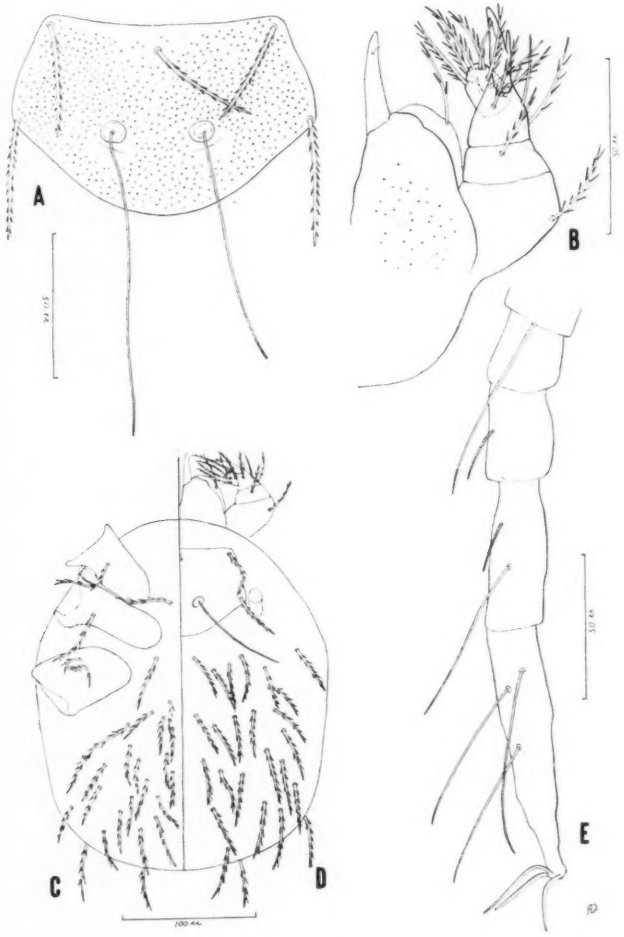


Fig. 3.—*Trombicula eusignata.* A. scutum, B. dorsal view of gnathosoma, C. venter, D. dorsum, and E. distal segments of leg III showing sensory setae.

TROMBICULA (NEOTROMBICULA) MICROTI Ewing, 1928

Plate I, Figs. 1, 4, Map 2

1928 *Trombicula microti* Ewing: p. 80; 1931 *Trombicula microti* Ewing: p. 9; 1937 *Trombicula microti* Ewing: p. 171; 1942 *Trombicula microti* Ewing: Radford, p. 57; 1942 *Trombicula parkeri* Radford: p. 62; 1946 *Trombicula microti* Ewing: Wharton, p. 176; 1946 *Trombicula microti* Ewing: Michener, p. 431; 1946 *Trombicula parkeri* Radford: p. 587; 1946 *Trombicula parkeri* Radford: Michener, p. 432; 1947 *Trombicula microti* Ewing: Thor and Willmann, p. 268; 1947 *Trombicula parkeri* Radford: p. 275; 1950 *Trombicula microti* Ewing: Philip and Fuller; 1950 *Trombicula parkeri* Radford: Philip and Fuller.

Body.—Color in life, red. Striae strong. Eyes 2 on each side on an ocular plate that is about 25 microns long. Length and width of a partially engorged specimen 387 by 225 microns. Anus situated at the level of the sixth row of ventral setae.

Gnathosoma.—Basal segments of chelicerae punctate, rounded laterally and with a slight superior lateral angle; distal segment typical. Seta on palpal coxa feathered; nude setae on the palpal femur (one specimen with this seta forked on one side), genu and the lateral aspect of the tibia; a branched dorsal and feathered ventral seta on the tibia; palpal claw with a large central prong and 2 smaller lateral prongs; palpal tarsus with a spur, subterminala, 6 ventral feathered setae, and a larger more robust dorsal seta. Galeal seta feathered. Occasional specimens have a nude galeal seta on one side.

Legs.—All coxae with a single feathered seta. Sensory setae are as follows: Leg I with paired genualae and a microgenuala between them, 2 tibialae in tandem with a microtibiala posterior to the distal tibiala, spur, microspur, located one-half the length of the spur from its base, subterminala, a simple parasubterminala, and a pretarsala. Leg II with 1 genuala, 2 tibialae in tandem, a spur and a mirospur just proximal to the base of the spur, and a pretarsala. Leg III with a mastifemorala, a genuala, a tibiala, a mastitibiala distal to the tibiala (1 specimen with 2 mastibialae on 1 leg), and 2 mastitarsalae (1 specimen with 3 mastitarsalae on 1 leg). All legs terminate in 2 lateral claws with a median claw-like empodium between them.

Scutum.—Pentagonal in shape with a somewhat rounded median posterior angle. Punctae small, numerous, and evenly distributed over the scutum. Sensillary bases just anterior to the level of the posterolateral setae. Sensillae with a few barbs along the distal two-thirds. Scutal setae with short barbs along their entire length. Three sets of Standard Data are given for comparison:

Locality	AW	PW	SB	ASB	PSB	AP	AM	AL	PL	S
New Mexico	76	97	30	29	29	32	55	52	69	81
Vermont	73	97	29	35	28	28	57	51	69	90
Canada	67	91	28	30	26	30	55	44	69	86
Labrador	76	93	28	36	26	30	59	50	69	—
Pennsylvania	73	94	28	33	24	30	55	51	65	70
Pennsylvania	79	98	30	39	26	32	55	50	65	76
Pennsylvania	81	101	33	35	26	33	62	52	72	—
Pennsylvania	75	92	29	33	25	29	50	44	69	73

Locality	AW	PW	SB	ASB	PSB	AP	AM	AL	PL	S
Type series of *T. parkeri* Radford 1942										
Colorado	81	102	30	35	32	29	45	44	50	—
Colorado	82	100	31	30	32	30	48	47	50	—
Colorado	83	105	30	39	31	29	—	47	52	83
Colorado	81	103	30	38	33	29	50	45	52	89

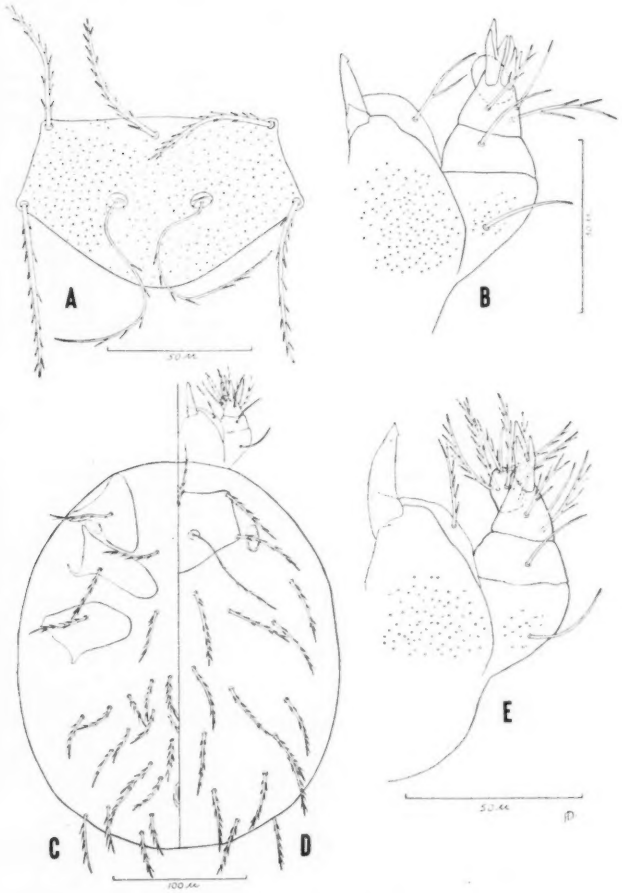


Fig. 4.—*Trombicula microti*. A. scutum, B. dorsal view of gnathosoma showing abnormal specimen with two palpal claws (palpal tarsal setae omitted), C. venter, D. dorsum, E. dorsal view of gnathosoma of normal specimen.

While the Standard Data of a series of specimens from one locality may differ significantly from those from another locality, there seems little to be gained in naming each population when considerable overlap occurs in most of the measurements.

Setae.—The body setae are similar to the scutal setae. Dorsal setae are arranged as a rule 2-6-6-6-4-4-2, although there is variation in the posterior rows. The anterior rows are fairly constant in specimens from the East, although an occasional individual occurs bearing 7 setae in the first posthumeral row. In the West however, series that show considerable variation in the number of anterior dorsal setae have been found. For example, the series of specimens on which Radford based his description of *T. parkeri* has from 6 to 11 setae in the first posthumeral row. The ventral setae are distributed 2-2 plus about 40.

Material studied.—Type U.S.N.M. No. 984.

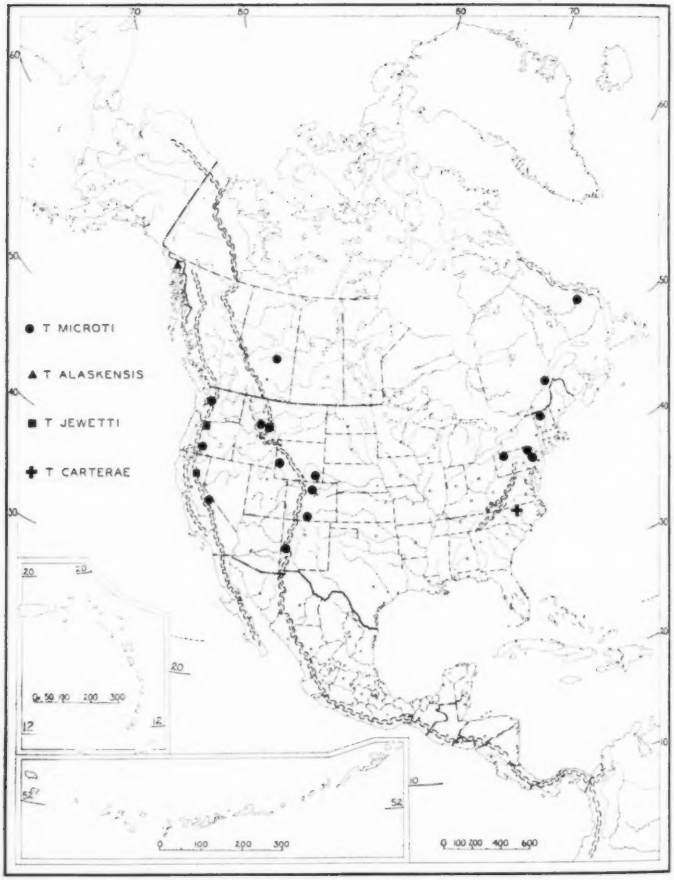
Host	Locality	Date	Collection	No. specimens
Tamiasciurus hudsonicus	Ravalli Co., Mont.	11 Aug. 1922	R.M.L.	2
Tamiasciurus hudsonicus	Ravalli Co., Mont.	25 Aug. 1922	A.H.	5
Microtus richardsoni	Lincoln Co., Wyo.	13 Aug. 1927	U.S.N.M.	Type
Ochotona princeps	Conejos Co., Colo.	9 Sept. 1931	R.M.L.	47
			D.U.	1
Blarina brevicauda	Orleans Co., Vt.	8 Sept. 1932	U.S.N.M.	1
Microtus mexicanus	Catron Co., N. Mex.	28 Aug. 1933	U.S.N.M.	1
Ochotona schisticeps	Mono Co., Calif.	27 Aug. 1940	R.M.L.	35
Eutamias alpinus	Mono Co., Calif.	29 Aug. 1940	R.M.L.	7
Microtus pennsylvanicus	Island of St. Lawrence River, Canada	————	U.S.N.M.	1
Neotoma cinerea	Ravalli Co., Mont.	1 Aug. 1945	R.M.L.	2
Sylvilagus nuttalli	Granite Co., Mont.	3 Aug. 1945	R.M.L.	11
Ochotona princeps	Granite Co., Mont.	3 Aug. 1945	R.M.L.	9
Neotoma cinerea	Ravalli Co., Mont.	12 Aug. 1945	K.U.	2
Scapanus townsendi	King Co., Wash.	14 Aug. 1945	R.M.L.	1
Neotoma cinerea	Ravalli Co., Mont.	15 Aug. 1945	H.S.F.	4
Tamiasciurus hudsonicus	Ravalli Co., Mont.	17 Aug. 1945	R.M.L.	12
Neotoma cinerea	Ravalli Co., Mont.	20 Aug. 1945	R.M.L.	1
Tamiasciurus hudsonicus	Ravalli Co., Mont.	20 Aug. 1945	R.M.L.	3
Tamiasciurus hudsonicus	Ravalli Co., Mont.	3 Sept. 1945	R.M.L.	3
Tamiasciurus hudsonicus	Ravalli Co., Mont.	24 Sept. 1945	B.M.	11
Tamiasciurus hudsonicus	Ravalli Co., Mont.	26 Sept. 1945	S.A.M.	6
Tamiasciurus hudsonicus	Ravalli Co., Mont.	27 Sept. 1945	R.M.L.	3
Peromyscus maniculatus	Ravalli Co., Mont.	10 Oct. 1945	R.M.L.	2
Glaucomys sabrinus	Ravalli Co., Mont.	10 Oct. 1945	R.M.L.	9
Tamiasciurus hudsonicus	Ravalli Co., Mont.	11 Oct. 1945	R.M.L.	2
Neotoma cinerea	Ravalli Co., Mont.	12 Oct. 1945	R.M.L.	1
Tamiasciurus hudsonicus	Ravalli Co., Mont.	16 Oct. 1945	R.M.L.	1
Microtus pennsylvanicus	Ravalli Co., Mont.	19 Oct. 1945	R.M.L.	5
Neotoma cinerea	Ravalli Co., Mont.	19 Oct. 1945	R.M.L.	1
Tamiasciurus hudsonicus	Ravalli Co., Mont.	25 Oct. 1945	R.M.L.	1
Blarina brevicauda	Wayne Co., Pa.	17 July 1946	D.U.	1
			R.M.L.	2
Blarina brevicauda	Wayne Co., Pa.	22 July 1946	R.M.L.	1
Blarina brevicauda	Wayne Co., Pa.	22 July 1946	R.M.L.	1

Host	Locality	Date	Collection	No. specimens
Clethrionomys gapperi	Wayne Co., Pa.	22 July 1946	R.M.L.	2
Blarina brevicauda	Wayne Co., Pa.	23 July 1946	R.M.L.	1
Blarina brevicauda	Wayne Co., Pa.	25 July 1946	R.M.L.	4
Blarina brevicauda	Wayne Co., Pa.	26 July 1946	R.M.L.	3
Clethrionomys gapperi	Wayne Co., Pa.	6 Aug. 1946	R.M.L.	2
Clethrionomys gapperi	Wayne Co., Pa.	8 Aug. 1946	R.M.L.	2
Microtus sp.	Crater Lake Natl. Park, Ore.	12 Aug. 1946	R.M.L.	37
Sorex dispar	Wayne Co., Pa.	13 Aug. 1946	R.M.L.	4
Microtus pennsylvanicus	Wayne Co., Pa.	13 Aug. 1946	R.M.L.	2
Blarina brevicauda	Wayne Co., Pa.	13 Aug. 1946	R.M.L.	1
Microtus pennsylvanicus	Wayne Co., Pa.	14 Aug. 1946	R.M.L.	2
Ochotona princeps	Albany Co., Wyo.	29 Aug. 1946	R.M.L.	2
Clethrionomys gapperi	Wayne Co., Pa.	21 July 1947	D.U.	1
Clethrionomys gapperi	Monroe Co., Pa.	20 July 1947	D.U.	3
Clethrionomys gapperi	Monroe Co., Pa.	20 July 1947	D.U.	4
Clethrionomys gapperi	Monroe Co., Pa.	20 July 1947	D.U.	1
Clethrionomys gapperi	Monroe Co., Pa.	8 Aug. 1947	D.U.	1
Blarina brevicauda	Warren Co., Pa.	15 Aug. 1947	D.U.	6
Microtus pennsylvanicus	Warren Co., Pa.	19 Aug. 1947	D.U.	1
Clethrionomys gapperi	Warren Co., Pa.	19 Aug. 1947	D.U.	4
Zapus hudsonius	Warren Co., Pa.	19 Aug. 1947	D.U.	3
Microtus pennsylvanicus	Warren Co., Pa.	19 Aug. 1947	D.U.	7
Ochotona princeps	Granite Co., Mont.	19 Aug. 1947	R.M.L.	8
Zapus hudsonius	Warren Co., Pa.	20 Aug. 1947	C.M.	1
Microtus pennsylvanicus	Warren Co., Pa.	20 Aug. 1947	C.M.	15
Clethrionomys gapperi	Warren Co., Pa.	29 Aug. 1947	C.M.	5
Clethrionomys gapperi	Warren Co., Pa.	20 Aug. 1947	C.M.	5
Blarina brevicauda	Warren Co., Pa.	22 Aug. 1947	C.M.	9
Ochotona princeps	Ravalli Co., Mont.	28 Aug. 1947	R.M.L.	10
Clethrionomys gapperi	Goose Bay, Labrador	25 Sept. 1947	U.S.N.M.	1
Clethrionomys gapperi	Edmonton, Alberta	2 Sept. 1948	D.U.	2
			R.M.L.	3
Eutamias amoenus	Edmonton, Alberta	2 Sept. 1948	R.M.L.	5
Peromyscus maniculatus	Edmonton, Alberta	2 Sept. 1948	R.M.L.	5
Microtus sp.	Rocky Mt. Natl. Park, Colo.	8 Sept. 1948	R.M.L.	6

Diagnosis.—*T. microti* can be recognized by the feathered galeal setae, nude setae on the palpal femur and genu, and sensillae with barbs along the distal two-thirds. No other species of the "microti" group has these characteristics.

Remarks.—The occurrence of variable populations of *T. microti*, such as the population on which *T. parkeri* of Radford is based, makes the study of the systematic position of many species of trombiculids extremely difficult. This same type of variation has caused considerable confusion to those who have attempted the systematic study of *Trombicula akamushi* and its allies, *Trombicula wichmanni* and its allies, and other groups. No general rule of thumb can be applied for resolving these difficulties. In the present case, all characters except the dorsal setal counts are consistent with those of *T. microti*. Since such variable populations have been found in Montana as well as Colorado, and since the type locality of *T. microti* is in Wyoming, it is probable

that *T. parkeri* is a synonym of *T. microti*. Some justification might be recognized for considering the eastern form as subspecifically different from the polymorphic western form, but too little data on the intermediate populations are available to make this course desirable. When more collections have been made, especially in central Canada, and when the ecology of the free living stages has been explained, many of the difficulties which now hamper a correct



Map 2.—Distribution of *T. microti*, *T. alaskensis*, *T. jewetti*, and *T. carterae*.

interpretation of the relationships between the eastern and western forms may disappear.

One interesting anomaly found in this species was a duplication of the tibial claw of the right palp, figure 4, on a specimen from Ravalli County, Montana.

TROMBICULA (NEOTROMBICULA) CALIFORNICA Ewing 1942

Map 4

1942 *Trombicula californica* Ewing: p. 488; 1946 *Trombicula californica* Ewing: Wharton, p. 176; 1946 *Trombicula californica* Ewing: Michener, p. 431; 1950 *Trombicula californica* Ewing: Philip and Fuller.

T. californica is an extremely variable species, apparently in all localities from which it is known.

Gnathosoma.—The seta on the palpal femur and the galeal seta may be nude or branched. Two specimens were studied that have a nude galeal seta on 1 side and a feathered seta on the other.

Legs.—In a few specimens there are minute barbs at the bases of the mastifemoralae. In 1 specimen microtibiala I was replaced by a tibiala on the left side.

Scutum.—The sensillae are invariably nude and lack even the smallest barbs or barbules. The Standard Data for several specimens follow:

	AW	PW	SB	ASB	PSB	AP	AM	AL	PL	S
Type	70	91	28	40	29	30	44	46	50	110
California	69	90	27	36	28	28	47	41	51	104
California	67	83	28	33	28	24	47	37	43	—
Montana	73	99	34	28	42	22	54	48	54	102
Montana	79	104	34	31	38	25	55	48	54	104
Idaho	73	102	34	31	37	24	42	43	50	80
Idaho	74	98	34	30	38	26	48	46	54	—

It is apparent from the Standard Data that the Rocky Mountain specimens have larger scutums than those from California. However, this difference is not sufficiently significant to be considered in the nomenclature of the group.

Setae.—Considerable variation is found in the number and arrangement of the body setae. The type specimen has dorsal setae as follows: 2-8-10-10-8-4-2 and ventral setae: 2-2 plus about 50. A series of 7 specimens from Huntington Lake, California has 8, 9, 9, 10, 10, 10, and 10 setae in the first posthumeral row. Four specimens from the Rocky Mountains have: 9, 9, 12, and 13 setae in the first posthumeral row.

Material studied.—Cotypes U.S.N.M. No. 1414.

Host	Locality	Date	Collection	No. specimens
Thomomys sp.	Fresno Co., Calif.	6 July 1932	U.S.N.M.	9
Wood Rat	Los Angeles Co., Calif.	9 Jan. 1933	U.S.N.M.	3
Thomomys neglectus	Acton, Calif.	12 Apr. 1933	U.S.N.M.	Type+6
Peromyscus maniculatus	Los Angeles Co., Calif.	8 Dec. 1940	R.M.L.	2
Tamiasciurus hudsonicus	Ravalli Co., Mont.	13 June 1945	R.M.L.	1
Tamiasciurus hudsonicus	Ravalli Co., Mont.	16 June 1945	R.M.L.	1
Citellus lateralis	Elmore Co., Ida.	26 June 1945	R.M.L.	1
Citellus lateralis	Blaine Co., Ida.	1 July 1945	R.M.L.	2
Sylvilagus nuttallii	Ravalli Co., Mont.	7 Apr. 1946	H.S.F.	1
Thomomys monticola	Fresno Co., Calif.	8 June 1948	D.U.	2
			A.H.	1
			B M.	1
			C.M.	1
			K.U.	1
			S.A.M.	1

Diagnosis.—*T. californica* is the only member of the "microti" group that has nude sensillae and a nude seta on the palpal genu.

Remarks.—*T. californica* varies so greatly that if it were not for the presence of uniformly nude sensillae it could not be separated from certain populations of western *T. microti* and *T. browni*. In fact, *T. browni* itself is separable only on the character of its sensillae.

The slide that bears the type No. 1414 in the U.S.N.M. has on it 7 specimens of *T. californica* arranged in 2 rows. The specimen mounted ventral side up in the row of 4 specimens is here designated as the lectotype. The original list of specimens reported by Ewing, 1942 includes 1 from Vancouver, B. C., collected by G. J. Spencer. This specimen is *T. cavicola* and not *T. californica*.

TROMBICULA (NEOTROMBICULA) HARPERI Ewing, 1928

Map 5

1928 *Trombicula harperi* Ewing: p. 79; 1931 *Trombicula harperi* Ewing: p. 8; 1938 *Eutrombicula harperi* Ewing: p. 294; 1942 *Eutrombicula harperi* Ewing: Radford, p. 67; 1947 *Trombicula* (*Eutrombicula*) *harperi* Ewing: Thor and Willmann, p. 285; 1950 *Trombicula harperi* Ewing: Philip and Fuller.

Gnathosoma.—Differs from *T. microti* only in having a nude galeal seta. In 1 specimen of *T. harperi* the galeal seta on one side is branched.

Legs.—Differ from *T. microti* in that the parasubterminala is frequently branched. One specimen of *T. harperi* has 3 mastitarsalae III on the left leg arranged as in the "bisignata" group.

Scutum.—Sensillae with barbs along the entire length. Standard data for 5 specimens follow:

	AW	PW	SB	ASB	PSB	AP	AM	AL	PL	S
Type	73	96	29	34	24	30	57	53	66	86
Pennsylvania	71	92	28	31	25	28	52	46	65	71
Pennsylvania	73	97	29	31	28	30	62	50	72	82
Wyoming	76	98	30	32	28	30	47	44	57	72
Colorado	84	110	35	35	33	30	47	55	70	90

The SB of 50 specimens measured varies from 25 to 35 microns. As in *T. microti* the specimens with the widest scutums are those from the western part of the range.

Setae.—The dorsal setae of the type are arranged: 2-8-6-4-2-4-2 and the ventral setae are: 2-2 plus about 50. However, the number of dorsal setae in the first posthumeral row varies from 7 to 10, although 36 of 50 specimens had 8 in this row.

Material studied.—Type U.S.N.M. No. 983.

Host	Locality	Date	Collection	No. specimens
Clethrionomys gapperi	Essex Co., N. Y.	27 July 1925	U.S.N.M.	5
Napeozapus insignis	Essex Co., N. Y.	Summer 1926	U.S.N.M.	Type
Microtus modestus	Jackson Co., Colo.	14 July 1926	U.S.N.M.	1
Clethrionomys gapperi	Piscataquis Co., Me.	21 Aug. 1928	U.S.N.M.	3
Napeozapus insignis	Piscataquis Co., Me.	22 Aug. 1928	U.S.N.M.	3
Peromyscus maniculatus	Piscataquis Co., Me.	25 Aug. 1928	U.S.N.M.	1
Clethrionomys gapperi	Piscataquis Co., Me.	27 Aug. 1928	U.S.N.M.	1
Citellus columbianus	Ravelli Co., Mont.	11 June 1931	R.M.L.	2
Neotoma sp.	Conejos Co., Colo.	19 Aug. 1931	R.M.L.	5
Ochotona princeps	Ravalli. Co,, Mont.	26 July 1944	R.M.L.	6
Ochotona princeps	Lemhi Co., Ida.	6 Aug. 1944	R.M.L.	15
Ochotona princeps	Ravalli Co., Mont.	30 July 1945	R.M.L.	10
Citellus lateralis	Ravalli Co., Mont.	30 July 1945	R.M.L.	7
Neotoma cinerea	Ravalli Co., Mont.	1 Aug. 1945	R.M.L.	13
Ochotona princeps	Ravalli Co., Mont.	1 Aug. 1945	R.M.L.	10
Peromyscus leucopus	Wayne Co., Pa.	3 Aug. 1945	D.U.	5
Eutamias amoenus	Missoula Co., Mont.	11 Aug. 1945	R.M.L.	1
Citellus lateralis	Missoula Co., Mont.	11 Aug. 1945	R.M.L.	2
Neotoma cinerea	Ravalli Co., Mont.	20 Aug. 1945	R.M.L.	4
Melospiza melodia	Wayne Co., Pa.	11 July 1946	D.U.	1
Clethrionomys gapperi	Wayne Co., Pa.	11 July 1946	R.M.L.	2
Clethrionomys gapperi	Wayne Co., Pa.	12 July 1946	D.U.	1
Peromyscus maniculatus	Wayne Co., Pa.	13 July 1946	D.U.	1
Peromyscus leucopus	Wayne Co., Pa.	16 July 1946	D.U.	2
Peromyscus maniculatus	Wayne Co., Pa.	25 July 1946	A.H.	2
Citellus lateralis	Ravalli Co., Mont.	25 July 1946	B.M.	4
Ochotona princeps	Lemhi Co., Ida.	25 July 1946	R.M.L.	12
Napeozapus insignis	Wayne Co., Pa.	26 July 1946	D.U.	1
Blarina brevicauda	Wayne Co., Pa.	26 July 1946	D.U.	1
Clethrionomys gapperi	Wayne Co., Pa.	27 July 1946	D.U.	1
Napeozapus insignis	Wayne Co., Pa.	30 July 1946	D.U.	1
Napeozapus insignis	Wayne Co., Pa.	31 July 1946	S.A.M.	2
Napeozapus insignis	Wayne Co., Pa.	31 July 1946	H.S.F.	2
Peromyscus maniculatus	Wayne Co., Pa.	1 Aug. 1946	K.U.	2
Clethrionomys gapperi	Wayne Co., Pa.	6 Aug. 1946	D.U.	2

Host	Locality	Date	Collection	No. specimens
Peromyscus maniculatus	Wayne Co., Pa.	6 Aug. 1946	D.U.	2
Microtus pennsylvanicus	Wayne Co., Pa.	10 Aug. 1946	D.U.	1
Peromyscus leucopus	Wayne Co., Pa.	10 Aug. 1946	D.U.	2
Microtus sp.	Beaver Co., Pa.	14 May 1947	C.M.	1
Tamiasciurus hudsonicus	Washakie Co., Wyo.	12 July 1947	K.U.	2
Microtus longicaudus	Carbon Co., Wyo.	— July 1947	K.U.	4
Peromyscus maniculatus	Washakie Co., Wyo.	14 July 1947	K.U.	3
Tamiasciurus hudsonicus	Washakie Co., Wyo.	16 July 1947	K.U.	1
Clethrionomys gapperi	Washakie Co., Wyo.	17 July 1947	K.U.	9
Clethrionomys gapperi	Washakie Co., Wyo.	18 July 1947	K.U.	4
Clethrionomys gapperi	Monroe Co., Pa.	19 July 1947	D.U.	4
Clethrionomys gapperi	Monroe Co., Pa.	19 July 1947	D.U.	19
Peromyscus leucopus	Monroe Co., Pa.	19 July 1947	D.U.	1
Napeozapus insignis	Monroe Co., Pa.	20 July 1947	D.U.	3
Clethrionomys gapperi	Monroe Co., Pa.	20 July 1947	D.U.	9
Peromyscus maniculatus	Monroe Co., Pa.	20 July 1947	D.U.	12
Clethrionomys gapperi	Monroe Co., Pa.	20 July 1947	D.U.	5
Peromyscus maniculatus	Wayne Co., Pa.	21 July 1947	D.U.	1
Napeozapus insignis	Wayne Co., Pa.	21 July 1947	D.U.	1
Clethrionomys gapperi	Wayne Co., Pa.	21 July 1947	D.U.	1
Clethrionomys gapperi	Monroe Co., Pa.	8 Aug. 1947	D.U.	8
Junco hyemalis	Boulder Co., Colo.	15 Aug. 1947	K.U.	1
Napeozapus insignis	Tompkins Co., N. Y.	31 Aug. 1947	R.M.L.	1

Diagnosis.—*T. harperi* is the only species in the group that has branched parasubterminalae, nude galeal setae, nude femoral and genual setae on the palpi, and as a rule 8 dorsal setae in the first posthumeral row.

Remarks.—*T. harperi* is distributed over the northeastern states and in the far west in much the same pattern as found for *T. microti* and *T. subsignata.*

TROMBICULA (NEOTROMBICULA) CAVICOLA Ewing, 1931
Plate II, Fig. 5, Map 5

1931 *Trombicula cavicola* Ewing: p. 14; 1938 *Eutrombicula cavicola* Ewing: p. 294; 1942 *Eutrombicula cavicola* Ewing: Radford, p. 67; 1947 *Trombicula* (*Eutrombicula*) *cavicola* Ewing: Thor and Willmann, p. 288.

Body.—Color in life, white.

Gnathosoma.—All setae on the first 4 palpal segments feathered.

Scutum.—Posterior margin quite evenly curved so that a median angle, characteristic of most species of *Neotrombicula*, is not suggested. Sensillae nude. Sensillary bases posterior to a hypothetical line connecting the bases of the posterior lateral setae. Standard Data for the type and the average of 10 specimens from Montana follow:

	AW	PW	SB	ASB	PSB	AP	AM	AL	PL	S
Type	68	88	34	32	17	42	62	52	74	81
Average	81	99	31	43	15	37	62	67	88	99

Setae.—The setae on the type specimen are obscure. Ewing, 1931, reports about 30 setae. Examination of the type revealed that the anterior setae were arranged 2-6-6- plus. Ventral setae 2-2 plus about 32. One of the Montana specimens has the following arrangement of the setae: dorsal 2-6-6-6-8-6-2-2; ventral 2-2 plus 42.

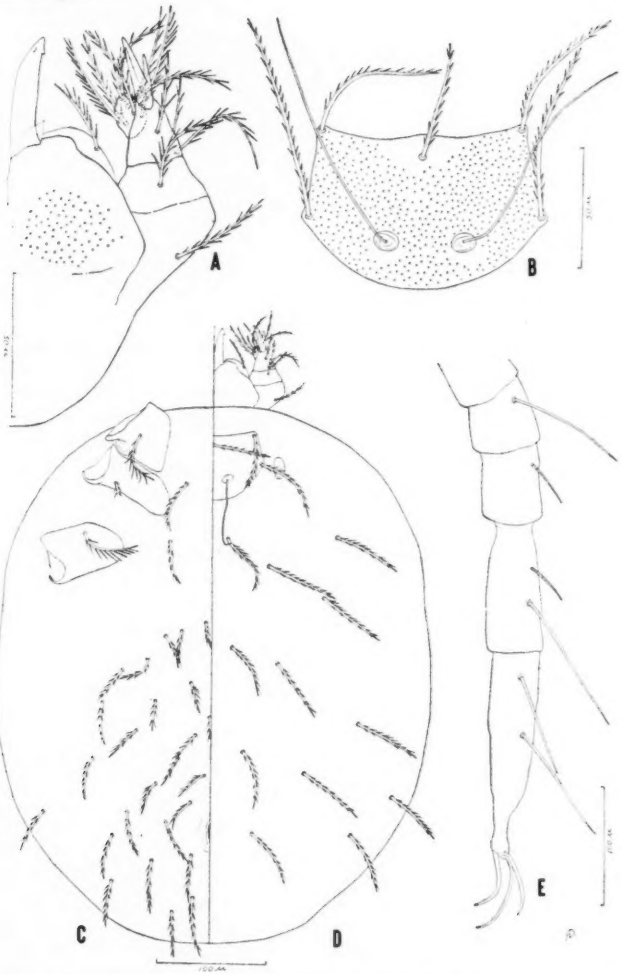


Fig. 5.—*Trombicula cavicola.* A. dorsal view of gnathosoma, B. scutum. C. venter, D. dorsum, E. leg III showing sensory setae.

Material studied.—Cotypes U.S.N.M. No. 1022.

Host	Locality	Date	Collection	No. specimens
Unknown	Reynolds Cave, Barren Co., Ky.	1881	U.S.N.M.	Type+3
Scapanus townsendi	Tillamook Co., Ore.	24 Mar. 1930	R.M.L.	7
Peromyscus maniculatus	Vancouver, B. C.	14 Jan. 1932	U.S.N.M.	1
Citellus lateralis	Ravalli Co., Mont.	12 June 1945	R.M.L.	3
Ochotona princeps	Ravalli Co., Mont.	16 June 1945	R.M.L.	20
Microtus oregoni	Pierce Co., Wash.	15 Feb. 1947	R.M.L.	1
Ochotona princeps	Ravalli Co., Mont.	28 Aug. 1947	D.U.	10

Diagnosis.—*T. cavicola* is characterized by the palpal setae on first 4 palpal segments feathered, nude sensillae, galeal seta feathered, and posterior margin of scutum broadly rounded.

Remarks.—Ewing has described the palpal claw as bifurcate, but examination of the type shows him to be in error in this regard since the claw is definitely trifurcate.

The Montana specimens have a much larger scutum than those from Kentucky. However, most of the western specimens seem to have larger scutums than their eastern relatives. Since insufficient evidence has been amassed to establish the clinal nature of this variation, further investigation of scutal size between eastern and western forms is indicated.

The type slide No. 1022 in the U.S.N.M. bears 4 specimens. The specimen nearest to the red label is here designated as the lectotype.

TROMBICULA (NEOTROMBICULA) ROHWERI Ewing, 1942

Map 5

1942 *Trombicula rohweri* Ewing: p. 488; 1946 *Trombicula rohweri* Ewing: Michener, p. 432; 1950 *Trombicula rohweri* Ewing: Philip and Fuller.

Gnathosoma.—All setae on first 4 palpal segments feathered. Galeal seta nude.

Scutum.—Sensillae nude. Standard Data for one of the cotypes follow:

	AW	PW	SB	ASB	PSB	AP	AM	AL	PL	S
Cotype	68	85	26	40	23	29	45	53	68	82

Setae.—Setal arrangement on type slide not apparent, anterior dorsal setae arranged 2-6- plus; ventral setae 2-2 plus. Ewing, 1942, reports 36 to 40 dorsal setae. One specimen collected from Linn Co., Missouri, has the following dorsal setal formula: 2-6-6-6-6-4-2; its ventral setae are arranged: 2-2 plus about 40. Three other specimens from Missouri have 6 dorsal setae in the first posthumeral row.

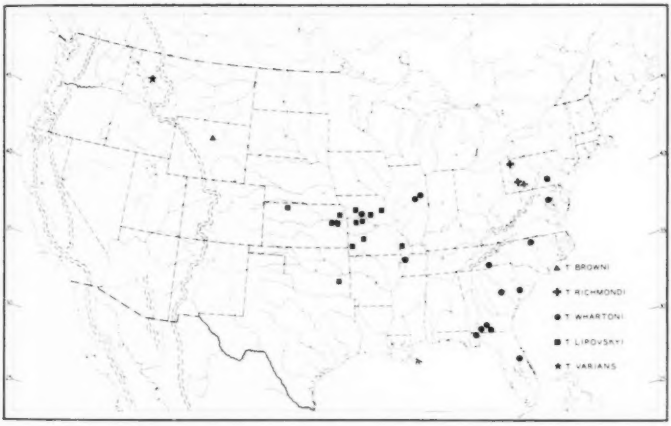
Material studied.—Cotypes U.S.N.M. No. 1413.

Host	Locality	Date	Collection	No. specimens
Troglodytes aedon	Handsboro, Miss.	14 Feb. 1940	U.S.N.M.	Type +3
Sylvilagus floridanus	Laclede Co., Mo.	15 Jan. 1943	R.M.L.	1
Sylvilagus floridanus	Linn Co., Mo.	21 Jan. 1943	D.U.	1
Sylvilagus floridanus	Jasper Co., Mo.	23 & 24 Jan. 1943	R.M.L.	2

Diagnosis.—*T. rohweri* is characterized as follows: feathered setae on the first 4 palpal segments, nude galeal seta, and nude sensillae.

Remarks.—*T. rohweri* is very close to *T. whartoni* from which it is separated by the entirely nude sensillae. However, since both forms occur in the same locality they probably represent 2 species.

The type slide of *T. rohweri* in the U.S.N.M. has 4 specimens on it. The second specimen from the right is here designated as the lectotype.



Map 3.—Distribution of *T. browni, T. richmondi, T. whartoni, T. lipovskyi,* and *T. varians.*

TROMBICULA (NEOTROMBICULA) WHARTONI Ewing, 1929

Plate III, Map 3

1929b *Trombicula whartoni* Ewing: p. 296; 1931 *Trombicula whartoni* Ewing: p. 10; 1936a *Trombicula whartoni* Ewing: Sugimoto, p. 204; 1936b *Trombicula whartoni* Ewing: Sugimoto, p. 243; 1942 *Trombicula whartoni* Ewing: Radford, p. 57; 1945 *Trombicula whartoni* Ewing: MacCreary, p. 127; 1946 *Trombicula whartoni* Ewing: Michener, p. 432; 1947 *Trombicula whartoni* Ewing: Thor and Willmann, p. 269; 1950 *Trombicula whartoni* Ewing: Philip and Fuller.

Body.—Color in life, red.

Gnathosoma.—Differs from *T. microti* in that all of the setae on the first 4 palpal segments are branched or feathered. Galeal seta nude.

Legs.—One of the 2 genualae I posterior rather than dorsal in position.

Scutum.—Sensillae with short basal barbs only. Punctae on scutum few and unevenly scattered. Standard Data for 6 specimens:

	AW	PW	SB	ASB	PSB	AP	AM	AL	PL	S
Type	72	94	26	39	23	32	46	48	68	88
North Carolina	69	79	28	41	21	30	51	51	72	82
North Carolina	69	86	26	37	26	32	48	48	76	91
North Carolina	69	83	24	26	26	28	46	43	72	91
North Carolina	70	83	28	25	25	26	48	55	75	99
North Carolina	67	79	28	25	25	26	43	54	75	90

Setae.—Dorsal setae arranged 2-6-6-6-4-2-2 in the type. Ventral setae not readily seen in type but 2-2 plus 14 left and 15 right on a specimen from Orange County, North Carolina. All specimens studied with 6 dorsal setae in the first posthumeral row.

Material studied.—Type U.S.N.M. No. 999.

Host	Locality	Date	Collection	No. specimens
Bird	Summerville, S. C.	————	U.S.N.M.	Type
Sylvilagus floridanus	Prince Georges Co., Md.	25 Nov. 1932	U.S.N.M.	9
Thryothorus ludovicianus	Pisgah Natl. Forest, N. C.	6 Dec. 1934	U.S.N.M.	5
Sigmodon hispidus	Leon Co., Fla.	9 Nov. 1936	U.S.N.M.	2
Sylvilagus floridanus	Dauphin Co., Pa.	9 Nov. 1939	R.M.L.	3
Sylvilagus floridanus	Carroll Co., Mo.	18 Jan. 1943	R.M.L.	1
Sylvilagus floridanus	Pemiscot Co., Mo.	28 Jan. 1943	R.M.L.	1
Sylvilagus floridanus	Prince Georges Co., Md.	16 Feb. 1943	U.S.N.M.	3
Junco hyemalis	Franklin Co., Miss.	1 Jan. 1945	U.S.N.M.	3
Sigmodon hispidus	Richmond Co., Ga.	18 Jan. 1946	R.M.L.	7
Cyanocita cristata	Douglas Co., Kans.	20 Oct. 1946	R.M.L.	1
Zonotrichia albicollis	Douglas Co., Kans.	20 Oct. 1946	R.M.L.	1
Pipilo erythrophthalmus	Orange Co., Fla.	24 Nov. 1946	S.A.M.	4
Canis familiaris	Prince Georges Co., Md.	10 Nov. 1947	RM.L.	1
Sylvilagus floridanus	Champaign Co., Ill.	23 Nov. 1947	R.M.L.	5
Sylvilagus floridanus	Orange Co., N. C.	30 Nov. 1947	K.U.	7
Sylvilagus floridanus	Orange Co., N. C.	30 Dec. 1947	H.S.F.	1
Sciurus carolinensis	Orange Co., N. C.	31 Dec. 1947	D.U.	1
Microtus pennsylvanicus	Orange Co., N. C.	3 Jan. 1948	B.M.	3
Sigmodon hispidus	Orange Co., N. C.	3 Jan. 1948	A.H.	3
Microtus pennsylvanicus	Orange Co., N. C.	4 Jan. 1948	D.U.	2
Microtus pennsylvanicus	Orange Co., N. C.	22 Feb. 1948	D.U.	2
Sciurus niger	Thomas Co., Ga.	15 Oct. 1948	U.S.N.M.	1
Sciurus carolinensis	Thomas Co., Ga.	8 Nov. 1948	U.S.N.M.	2
Sciurus carolinensis	Grady Co., Ga.	2 Dec. 1948	U.S.N.M.	1
Sciurus carolinensis	Brooks Co., Ga.	7 Dec. 1948	U.S.N.M.	2
Sciurus carolinensis	Grady Co., Ga.	16 Dec. 1948	U.S.N.M.	1
Sciurus carolinensis	Grady Co., Ga.	22 Dec. 1948	U.S.N.M.	1
Sciurus carolinensis	Grady Co., Ga.	24 Dec. 1948	U.S.N.M.	2
Sciurus niger	Brooks Co., Ga.	18 Jan. 1949	U.S.N.M.	1

Diagnosis.—*T. whartoni* has basal barbs on the sensillae, few scattered punctae on the scutum, and feathered setae on the first 4 palpal segments.

Remarks.—*T. whartoni* has been found only in the southern and eastern regions of the United States. In the middle west it is replaced by *T. lipovskyi* n. sp.

Trombicula (Neotrombicula) lipovskyi n. sp.
Plate III, Map 3

T. lipovskyi agrees with *T. whartoni* in all respects with the exception of certain scutal characters.

Scutum.—With numerous small evenly distributed punctae as in *T. microti.* Sensillae with small barbs along its entire length. Basal barbs are longer than the distal barbs. The Standard Data for 5 specimens follow:

	AW	PW	SB	ASB	PSB	AP	AM	AL	PL	S
Type	65	79	22	32	23	26	51	50	75	90
Kansas	65	84	28	36	23	32	55	54	86	—
Kansas	76	83	28	35	22	26	48	57	70	73
Kansas	66	79	25	37	22	26	48	48	69	90
Kansas	67	83	24	37	23	29	46	50	76	86

These Standard Data overlap those of *T. whartoni.*

Diagnosis.—*T. lipovskyi* is separable from *T. whartoni* by virtue of its more numerous scutal punctae and distal barbs on the sensillae.

Remarks.—As stated in the preceding description, apparently *T. lipovskyi* displaces *T. whartoni* in the midwest, therefore suggesting the likelihood of subspecificity. However, it seems desirable to maintain specific rank for both until more data become available. *T. lipovskyi* is named for L. J. Lipovsky who is studying the biology of trombiculid mites at Kansas University.

Material studied.—Type U.S.N.M. No. 1838.

Host	Locality	Date	Collection	No. specimens
Wood rat	Latimer Co., Okla.	17 Mar. 1929	U.S.N.M.	1
Sylvilagus floridanus	Laclede Co., Mo.	15 Jan. 1943	A.H.	2
Sylvilagus floridanus	Caldwell Co., Mo.	15 Jan. 1943	H.S.F.	2
Sylvilagus floridanus	Pike Co., Mo.	15 Jan. 1943	B.M.	2
Sylvilagus floridanus	Stoddard Co., Mo.	18 Jan. 1943	R.M.L.	7
Sylvilagus floridanus	Howard Co., Mo.	22 Jan. 1943	R.M.L.	1
Sylvilagus floridanus	Pettis Co., Mo.	22 Jan. 1943	R.M.L.	1
Sylvilagus floridanus	Jasper Co., Mo.	23 Jan. 1943	S.A.M.	2
Sylvilagus floridanus	Johnson Co., Mo.	28 Jan. 1943	R.M.L.	1
Canis latrans	Douglas Co., Kans.	11 Jan. 1946	D.U.	1
Sylvilagus floridanus	Leavenworth Co., Kans.	7 Oct. 1946	R.M.L.	3
Peromyscus sp.	———, Kans.	———	R.M.L.	3
Peromyscus sp.	Norton Co., Kans.	25 Oct. 1946	U.S.N.M.	Type+3
Reithrodontomys fulvescens	Norton Co., Kans.	26 Oct. 1946	K.U.	2
Neotoma floridana	Douglas Co., Kans.	2 Nov. 1946	R.M.L.	20

Trombicula (Neotrombicula) alaskensis n. sp.
Map 2

Gnathosoma.—Except for the lateral seta on the palpal tibia, all of the setae on the first 4 palpal segments have barbs. Galeal seta nude.

Scutum.—Sensillae with a series of minute basal barbs. The Standard Data for the type and 2 other specimens follow:

	AW	PW	SB	ASB	PSB	AP	AM	AL	PL	S
Type	77	104	32	40	35	35	59	52	72	105
Juneau, Alaska	79	101	32	39	29	29	59	55	66	104
Juneau, Alaska	79	105	32	40	33	30	63	55	76	110

Setae.—Dorsal setae of type arranged 2-13-3-11-11-6-6-5-3; ventral setae: 2-2 plus 20 left and 20 right. First posthumeral row of other 2 specimens 11 and 13.

Material studied.—Type U.S.N.M. No. 1839.

Host	Locality	Date	Collection	No. specimens
Hylocichla ustulata	Juneau, Alaska	6 June 1948	U.S.N.M.	Type
			D.U.	1
			R.M.L.	1

Diagnosis.—*T. alaskensis* is characterized by the following features: Nude galeal seta, nude lateral seta on the palpal tibia, feathered setae on palpal femur and genu, sensillae nude except for minute basal barbs, and more than 10 setae in the first posthumeral row.

Remarks.—The specimens described here were collected by R. B. Williams.

Trombicula (Neotrombicula) browni n. sp.
Map 3

Body.—Striae weaker than in *T. microti.* Color in life, red.

Gnathosoma.—Galeal seta with fewer branches than in *T. microti.* Careful examination is required to see the barbs and in 1 of the 4 specimens no barbs could be detected. In other respects the gnathosoma is similar to *T. microti.*

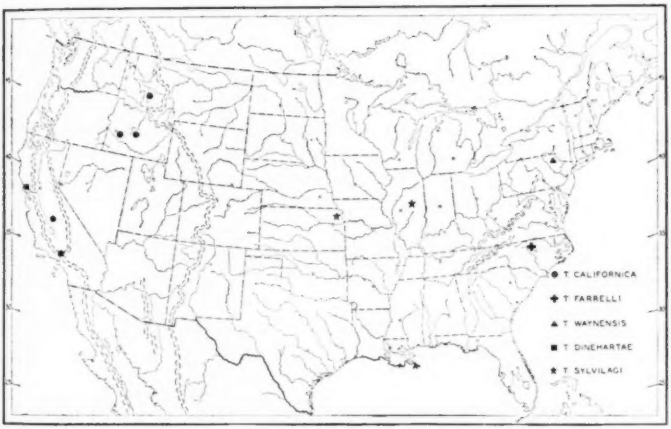
Scutum.—The sensillae are radically different from those of *T. microti* in that they have only short basal and no distal barbs. Standard Data for the 4 specimens available follow:

	AW	PW	SB	ASB	PSB	AP	AM	AL	PL	S
Type	83	101	30	39	30	30	44	46	51	91
	76	104	30	37	29	35	50	48	52	83
	83	104	30	40	35	33	48	50	52	90
	79	105	30	39	29	33	55	51	66	97

Setae.—The dorsal setae of the type specimen are arranged: 2-10-4-11-9-12-8-4-2. Its ventral setae are arranged: 2-2 plus 28 on the left side and 25 on the right. The first posthumeral row of dorsal setae in the other 3 specimens have 11, 11, and 12 setae respectively.

Material studied.—Type U.S.N.M. No. 1840.

Host	Locality	Date	Collection	No. specimens
Peromyscus maniculatus	Ten Sleep, Wyo.	13 July 1947	U.S.N.M.	Type
Microtus longicaudus	Ten Sleep, Wyo.	13 July 1947	D.U.	1
Tamiasciurus hudsonicus	Washakie Co., Wyo.	17 July 1947	R.M.L.	1
			D.U.	1



Map 4.—Distribution of *T. californica*, *T. farrelli*, *T. waynensis*, *T. dinehartae*, and *T. sylvilagi*.

Diagnosis.—*T. browni* can be separated from other members of the "microti" group by the following combination of characters: Nude setae on the palpal femur and genu, and basal barbs on the otherwise naked sensillae.

Remarks.—*T. browni* is named for J. R. C. Brown, who is investigating the histology of trombiculid mites at Duke University.

Trombicula (Neotrombicula) dinehartae n. sp.

Plate IV, Map 4

Gnathosoma.—Setae on first 4 palpal segments feathered.

Legs.—Microsetae all prominent and larger than those found in other members of the group. Three genualae I present.

Scutum.—Anterior median seta of the single available specimen not present. Sensillae nude. Standard Data for the type follow:

	AW	PW	SB	ASB	PSB	AP	AM	AL	PL	S
Type	60	84	24	30	22	29	—	49	55	66

Setae.—Dorsal setae arranged: 2-6-6-6-2-4-2-2; ventral setae: 2-2 plus about 32.

Material studied.—Type R.M.L. No. 21448 (holotype).

Host	Locality	Date	Collection	No. specimens
Peromyscus maniculatus	Marin Co., Calif.	22 Nov. 1944	R.M.L.	Type

Diagnosis.—*T. dinehartae* is the only member of the "microti" group that has 3 genualae I.

Remarks.—*T. dinehartae,* although it fits the characteristics of the "microti" group, except for the absence of the anterior median seta, is not as closely related to the group as are the other species. The large microsensory setae at once set this species apart from the rest. This species based on a single specimen, is tentatively placed in the genus *Trombicula* and is included in this paper because it is highly probable that the absence of the anterior median seta is an anomaly.

T. dinehartae is named for Miss Alma Dinehart, Staff Artist, Rocky Mountain Laboratory, who prepared the illustrations for this paper.

Trombicula (Neotrombicula) goodpasteri n. sp.

Map 5

Body.—Color in life red.

Gnathosoma.—All palpal setae on the first 4 segments feathered. Galeal seta nude.

Legs.—A few basal barbs on mastifemoralae III on 5 of 11 specimens.

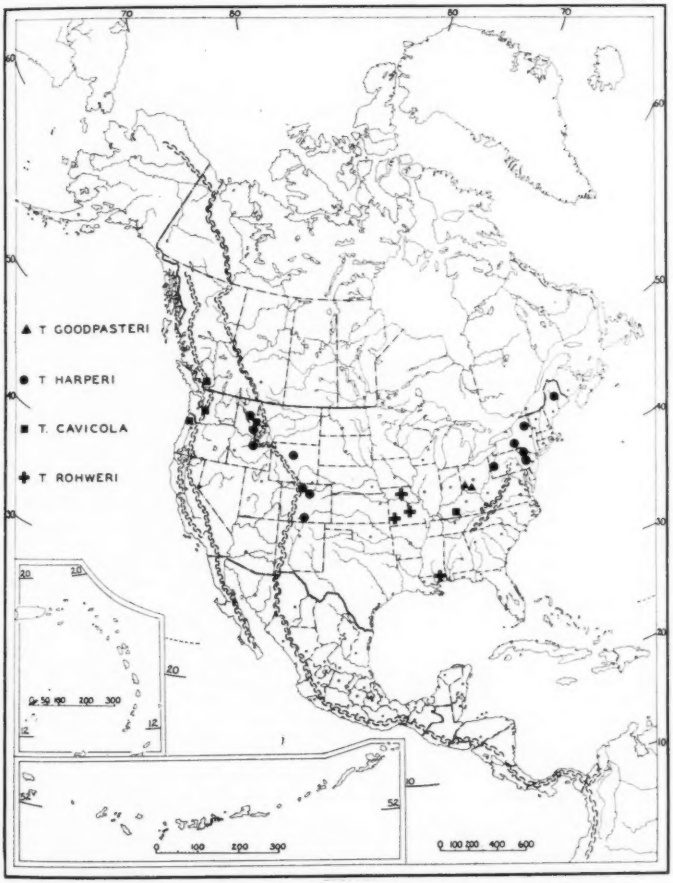
Scutum.—Sensillae with only basal barbs. The Standard Data for 5 specimens follow:

	AW	PW	SB	ASB	PSB	AP	AM	AL	PL	S
Type	62	83	25	37	25	28	55	46	77	83
Ohio	62	76	24	32	22	23	47	41	69	90
Ohio	62	83	24	36	23	26	51	48	76	90
Ohio	66	83	24	35	22	24	48	50	73	77
Ohio	62	83	25	35	22	28	50	45	72	97

Setae.—The dorsal setae of the type are arranged: 4-9-6-4-6 plus 7 left and 4 right; ventral setae: 2-2 plus 20 left and 21 right. The number of humeral setae varies from 3 to 5. The number of dorsal setae in the first posthumeral row varies from 6 to 9.

Material studied.—Type U.S.N.M. No. 1841.

Host	Locality	Date	Collection	No. specimens
Pitymys pinetorum	Hamilton Co., Ohio	1 Mar. 1948	B.M.	1
Microtus pennsylvanicus	Clermont Co., Ohio	4 Mar. 1948	R.M.L.	2
Pitymys pinetorum	Clermont Co., Ohio	4 Mar. 1948	U.S.N.M.	Type + 1
Pitymys pinetorum	Hamilton Co., Ohio	5 Mar. 1948	S.A.M.	1
Microtus pennsylvanicus	Clermont Co., Ohio	15 Mar. 1948	K.U.	1
Microtus pennsylvanicus	Clermont Co., Ohio	15 Mar. 1948	H.S.F.	1
Microtus pennsylvanicus	Clermont Co., Ohio	16 Mar. 1948	D.U.	1
Microtus pennsylvanicus	Clermont Co., Ohio	16 Mar. 1948	D.U.	1
Microtus pennsylvanicus	Clermont Co., Ohio	20 Mar. 1948	D.U.	1



Map 5.—Distribution of *T. goodpasteri, T. harperi, T. cavicola, and T. rohweri.*

Diagnosis.—*T. goodpasteri* has the following combination of characters that will distinguish it from the other members of the "microti" group: More than 2 humeral setae, all setae on the palpal tibia feathered, and a nude galeal seta.

Remarks.—*T. goodpasteri* is named for its collector, *Woodrow Goodpaster* of the Cincinnati Museum.

Trombicula (Neotrombicula) jewetti n. sp.
Map 2

Gnathosoma.—All setae on the first 4 palpal segments feathered. In a few specimens the lateral tibial seta is forked on one palp and nude on the other.

Legs.—One specimen with 3 tibialae I.

Scutum.—Sensillae with short barbs on basal half only. Punctae extremely heavy over entire scutum. Standard Data for 5 specimens follow:

	AW	PW	SB	ASB	PSB	AP	AM	AL	PL	S
Type	76	95	29	43	24	32	69	64	87	93
California	76	95	29	43	24	33	64	62	86	—
California	79	100	31	45	26	35	62	59	88	—
Oregon	55	75	21	43	18	37	55	51	72	79
Oregon	62	79	22	44	15	35	61	55	72	—

Setae.—Dorsal setal formula variable, in 1 specimen 2-6-6-4-4-2-2-2, in another 2-6-2-6-6-4-2; all specimens have 6 setae in the first posthumeral row. Ventral setae 2-2 plus about 46.

Material studied.—Type R.M.L. No. 25972 (holotype).

Host	Locality	Date	Collection	No. specimens
Microtus townsendi	Portland, Ore.	20 Dec. 1931	U.S.N.M.	3
Microtus longicaudus	Plumas Co., Calif.	27 Oct. 1948	R.M.L.	4
			S.A.M.	1
			H.S.F.	1
Clethrionomys californicus	Plumas Co., Calif.	29 Oct. 1948	D.U.	3
Peromyscus maniculatus	Plumas Co., Calif.	31 Oct. 1948	R.M.L.	1
Clethrionomys californicus	Plumas Co., Calif.	6 Nov. 1948	B.M.	2
Clethrionomys californicus	Plumas Co., Calif.	7 Nov. 1948	A.H.	1
Sorex trowbridgii	Plumas Co., Calif.	14 Nov. 1948	R.M.L.	2
Peromyscus boylii	Plumas Co., Calif.	8 Dec. 1948	R.M.L.	2
			U.S.N.M.	1
Clethrionomys californicus	Plumas Co., Calif.	9 Dec. 1948	R.M.L.	4
Neotoma sp.	Plumas Co., Calif.	10 Dec. 1948	R.M.L.	3
Clethrionomys californicus	Plumas Co., Calif.	11 Dec. 1948	R.M.L.	Type+4
Peromyscus boylii	Plumas Co., Calif.	14 Feb. 1949	R.M.L.	1
Peromyscus boylii	Plumas Co., Calif.	15 Feb. 1949	R.M.L.	2
Peromyscus maniculatus	Plumas Co., Calif.	17 Feb. 1949	R.M.L.	1
Clethrionomys californicus	Plumas Co., Calif.	22 Feb. 1949	R.M.L.	6
Sorex trowbridgii	Plumas Co., Calif.	3 Mar. 1949	R.M.L.	1
Sorex trowbridgii	Plumas Co., Calif.	9 Mar. 1949	R.M.L.	1
Peromyscus maniculatus	Plumas Co., Calif.	9 Mar. 1949	R.M.L.	7
Microtus longicaudus	Plumas Co., Calif.	10 Mar. 1949	R.M.L.	9

Diagnosis.—*T. jewetti* can be separated from other species by the feathered palpal setae on the first 4 segments, feathered galea seta, and sensillae with basal barbs only.

Remarks.—*T. jewetti* is named for S. G. Jewett, of the U. S. Fish and Wildlife Service, who made the earliest collection.

Trombicula (Neotrombicula) richmondi n. sp.

Map 3

Body.—Color in life, red.

Gnathosoma.—All palpal setae on the first 4 segments with barbs. Galeal seta nude.

Legs.—Leg I with a single genuala. Basal barbs on approximately half of the mastifemoralae III.

Scutum.—Differs from *T. microti* in that the barbs are short and restricted to the basal portion. The Standard Data for 5 specimens follow:

	AW	PW	SB	ASB	PSB	AP	AM	AL	PL	S
Type	75	91	28	39	28	30	51	57	79	103
Pennsylvania	69	90	28	36	28	32	50	58	69	97
Pennsylvania	65	86	28	41	22	30	63	62	73	93
Pennsylvania	66	86	28	41	23	30	62	68	79	—
Pennsylvania	69	78	28	39	22	32	52	52	73	104

Setae.—Dorsal setal formula of type 2-6-6-4-8-2-2 ;ventral setae 2-2 plus approximately 46.

Material studied.—Type C.M. No. unassigned.

Host	Locality	Date	Collection	No. specimens
Microtus pennsylvanicus	Venango Co., Pa.	8 Apr. 1947	C.M.	10
Napeozapus insignis	Somerset Co., Pa.	27 Sept. 1947	B.M.	1
Microtus pennsylvanicus	Somerset Co., Pa.	13 Oct. 1947	R.M.L.	8
Ondatra zibethica	Somerset Co., Pa.	14 Oct. 1947	C.M.	4
Microtus pennsylvanicus	Somerset Co., Pa.	15 Oct. 1947	S.A.M.	1
Microtus pennsylvanicus	Somerset Co., Pa.	16 Oct. 1947	C.M.	Type
Ondatra zibethica	Somerset Co., Pa.	17 Oct. 1947	D.U.	4
Microtus pennsylvanicus	Somerset Co., Pa.	20 Oct. 1947	U.S.N.M.	2
Clethrionomys gapperi	Westmoreland Co., Pa.	27 Feb. 1948	K.U.	1
Clethrionomys gapperi	Westmoreland Co., Pa.	28 Feb. 1948	H.S.F.	1

Diagnosis.—*T. richmondi* is the only species of the "microti" group in which there is a single genuala on leg I.

Remarks.—This species is named for Neil Richmond, its collector. It is closely related to *T. whartoni* as is suggested by its morphology and its presence on hosts during the cooler months of the year.

UNGROUPED SPECIES

Five miscellaneous species that do not conform to either the "bisignata" or "microti" group are included here. These species differ from both *Trombicula bisignata* and *Trombicula microti* principally in the arrangement of the whip-like setae on the posterior legs. In order to avoid repetition these species will be compared to *T. microti*.

KEY TO SPECIES

1. Galeal seta branched ..... *T. varians* n. sp.
   Galeal seta nude 2
2. One genuala I 3
   More than one genuala I 4
3. Dorsal setal formula begins 2-6- ..... *T. carterae* n. sp.
   Dorsal setal formula begins 4-4- ..... *T. farrelli* n. sp.
4. Two genualae I ..... *T. waynensis* n. sp.
   Three genualae I ..... *T. sylvilagi* n. sp.

Trombicula (Neotrombicula) carterae n. sp.

Map 2

Body.—Color in life, orange or pink.

Gnathosoma.—All setae on the first 4 palpal segments feathered. Galeal seta nude.

Legs.—One genuala I (1 specimen with 2 genuala on 1 leg). Mastifemorala III lacking.

Scutum.—Barbs on sensillae restricted to basal portions. Standard Data for 3 specimens follow:

	AW	PW	SB	ASB	PSB	AP	AM	AL	PL	S
North Carolina	63	79	28	41	22	26	55	44	79	83
North Carolina	66	79	28	39	22	28	55	46	76	90
North Carolina	65	79	29	39	21	26	55	48	76	90

Setae.—Dorsal setae arranged 2-6-8-6-4-4-2; ventral setae 2-2 plus about 48. All specimens with 6 setae in the first posthumeral row.

Material studied.—Type U.S.N.M. No. 1843.

Host	Locality	Date	Collection	No. specimens
Peromyscus sp.	Orange Co., N. C.	7 Dec. 1947	U.S.N.M.	Type+1
Peromyscus sp.	Orange Co., N. C.	28 Dec. 1947	R.M.L.	1
Peromyscus sp.	Orange Co., N. C.	1 Jan. 1948	D.U.	1

Diagnosis.—*T. carterae* is distinguished by a single genuala I, the absence of a mastifemorala III, and 2 humeral setae.

Remarks.—*T. carterae* is named for Virginia Carter who prepares most of the trombiculids for study at Duke University.

Trombicula (Neotrombicula) farrelli n. sp.
Plate II, Fig. 6, Map 4

Gnathosoma.—Feathered setae on the first 4 palpal segments. Galea seta nude.

Legs.—One genuala I. No mastifemorala III, but in its place a seta with long barbs on the proximal half.

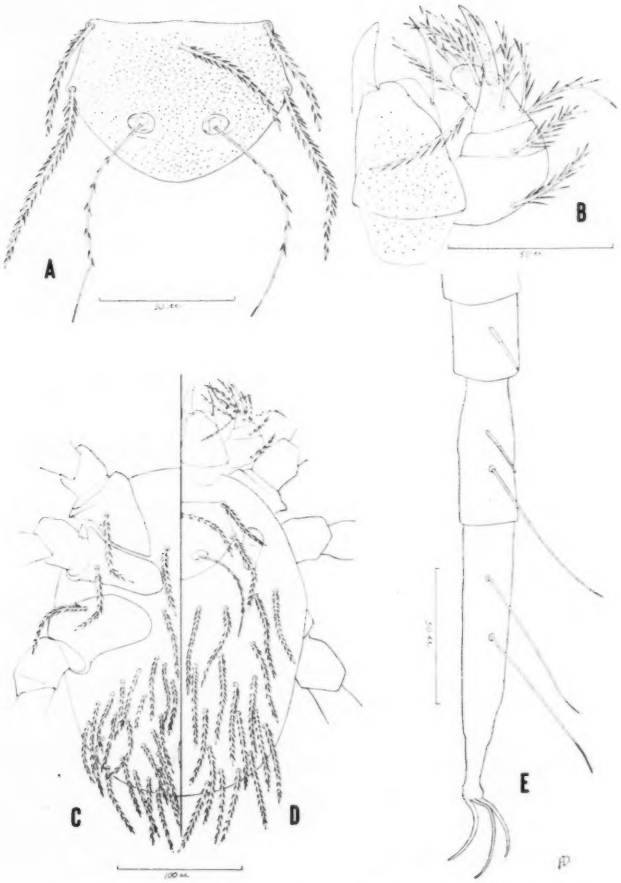


Fig. 6.—*Trombicula farrelli.* A. scutum, B. dorsal view of gnathosoma, C. venter, D. dorsum, E. leg III showing sensory setae.

Scutum.—Sensillae with basal barbs only. Standard Data for 3 specimens follow:

	AW	PW	SB	ASB	PSB	AP	AM	AL	PL	S
North Carolina	58	79	28	41	23	28	57	50	83	76
North Carolina	62	77	26	39	21	25	59	40	73	90
North Carolina	59	76	26	36	23	28	55	50	75	79

Setae.—Dorsal setae arranged: 4-4-3-7-3-7-4-4-2; ventral setae: 2-2 plus about 44. Humeral setae, 2 on each side in all specimens; first posthumeral row a median group of 4.

Material studied.—Type U.S.N.M. No. 1844.

Host	Locality	Date	Collection	No. specimens
Peromyscus sp.	Orange Co., N. C.	25 Dec. 1947	D.U.	1
Peromyscus sp.	Orange Co., N. C.	2 Jan. 1948	U.S.N.M.	Type
			R.M.L.	1

Diagnosis.—*T. farrelli* is distinguished by 1 genuala I, no mastifemorala III, and a dorsal setal formula that begins 4-4.

Remarks.—*T. farrelli* is named for its collector C. E. Farrell of Duke University.

Trombicula (Neotrombicula) sylvilagi n. sp.
Plate IV, Fig. 7, Map 4

Gnathosoma.—Dorsal tibial seta of palp nude. Galeal seta nude, except on right side of 1 specimen.

Legs.—Three genualae I, no mastifemorala III, 2 mastitibialae III.

Scutum.—Standard Data for 5 specimens:

	AW	PW	SB	ASB	PSB	AP	AM	AL	PL	S
Kansas	77	81	30	28	33	26	44	40	52	63
Kansas	76	79	31	27	30	25	42	38	52	67
Kansas	71	83	29	26	36	29	42	40	52	64
Illinois	74	81	27	26	33	26	—	41	54	66
Illinois	71	85	30	28	34	27	—	40	52	69

Setae.—Dorsal setae arranged 2-6-6-6-6-2-2; ventral setae 2-2 plus 26. One specimen with 7 setae in the first posthumeral row.

Material studied.—Type R.M.L. No. 23242 (holotype).

Host	Locality	Date	Collection	No. specimens
Sylvilagus floridanus	Leavenworth Co., Kans.	7 Oct. 1946	R.M.L.	Type+1
			D.U.	1
Synaptomys sp.	Piatt Co., Ill.	6 Oct. 1948	R.M.L.	2

Diagnosis.—*T. sylvilagi* can be recognized by its 2 mastitibialae III.

Remarks.—*T. sylvilagi* is similar to *T. dinehartae* in possessing 3 genualae I, but differs in so many other characters that its position is doubtful.

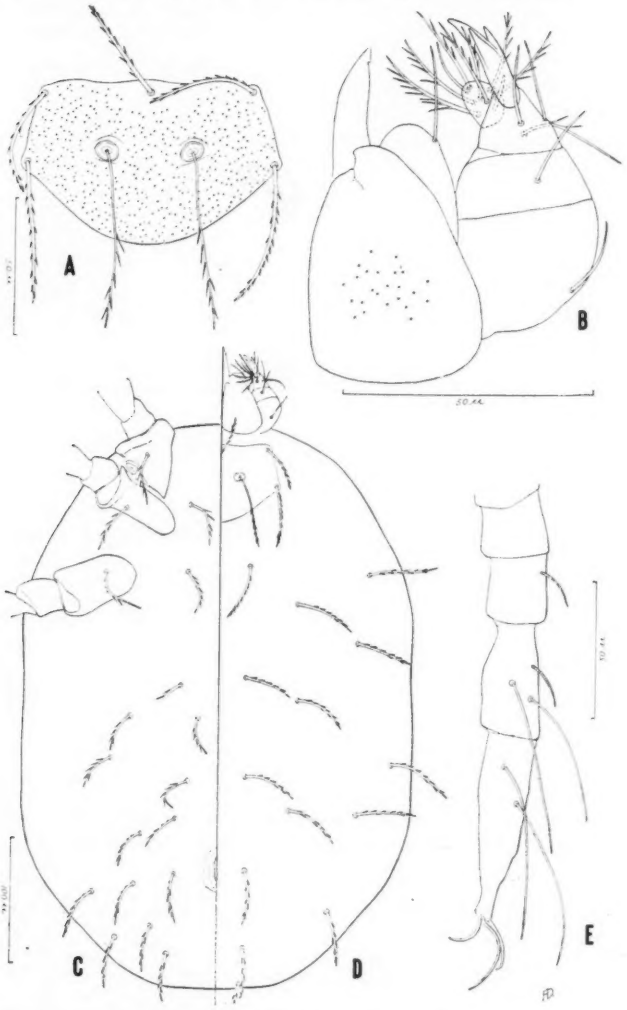


Fig. 7.—*Trombicula sylvilagi*. A. scutum, B. dorsal view of gnathosoma, C. venter, D. dorsum, E. leg III showing sensory setae.

Trombicula (Neotrombicula) varians n. sp.
Fig. 8, Map 3

Body.—Color in life, red.

Gnathosoma.—Setae on first 4 palpal segments feathered except the lateral tibial seta which is usually nude. In 2 specimens the lateral tibial seta on 1 palp is forked.

Legs.—Typically, 3 mastitarsalae III. Three specimens with 2 mastitarsalae III on one leg and 3 on the other.

Scutum.—Sensillae apparently nude, but minute barbs seen along entire length of sensillae in one specimen. Standard Data for 5 specimens follow:

	AW	PW	SB	ASB	PSB	AP	AM	AL	PL	S
Type	74	96	28	34	22	30	42	36	43	76
Montana	72	91	28	38	22	36	42	43	48	98
Montana	78	95	28	38	24	30	43	42	44	92
Montana	72	98	28	41	24	34	42	44	46	85
Montana	73	97	29	40	23	34	43	41	42	102

Setae.—Dorsal setae irregularly arranged, about 46 in 4 poorly defined rows. Humeral setae 2 in all specimens. First posthumeral row varies from 10 to 14. Ventral setae 2-2 plus about 40.

Material studied.—Type R.M.L. No. 21679 (holotype).

Host	Locality	Date	Collection	No. specimens
Citellus columbianus	Missoula Co., Mont.	17 Apr. 1945	R.M.L.	Type+3
			U.S.N.M.	2
			D. U.	2

Diagnosis.—*T. varians* can be recognized by the apparently nude sensillae, 1 mastifemorala III, 1 mastitibiala III, and 3 mastitarsalae III.

Remarks.—*T. varians* is perhaps the most variable of the species discussed in this report.

Trombicula (Neotrombicula) waynensis n. sp.
Map 4

Gnathosoma.—Feathered setae on palpal femur and genu. Branched dorsal, nude lateral, and feathered ventral seta on palpal tibia. Galeal seta nude.

Legs.—No mastifemorala III.

Scutum.—The Standard Data for the type and 3 other specimens follow:

	AW	PW	SB	ASB	PSB	AP	AM	AL	PL	S
Type	84	104	32	32	33	26	54	57	75	90
Pennsylvania	81	97	30	37	33	30	—	55	72	—
Pennsylvania	—	102	30	—	27	—	55	55	76	101
Pennsylvania	83	109	30	39	32	30	54	59	83	—

Setae.—Dorsal setae of type arranged: 2-11-9-10-6-6-4; ventral setae: 2-2 plus 27 left and 27 right. The first posthumeral row of dorsal setae in the other 3 specimens are: 9, 10, and 10.

Material studied.—Type U.S.N.M. No. 1845.

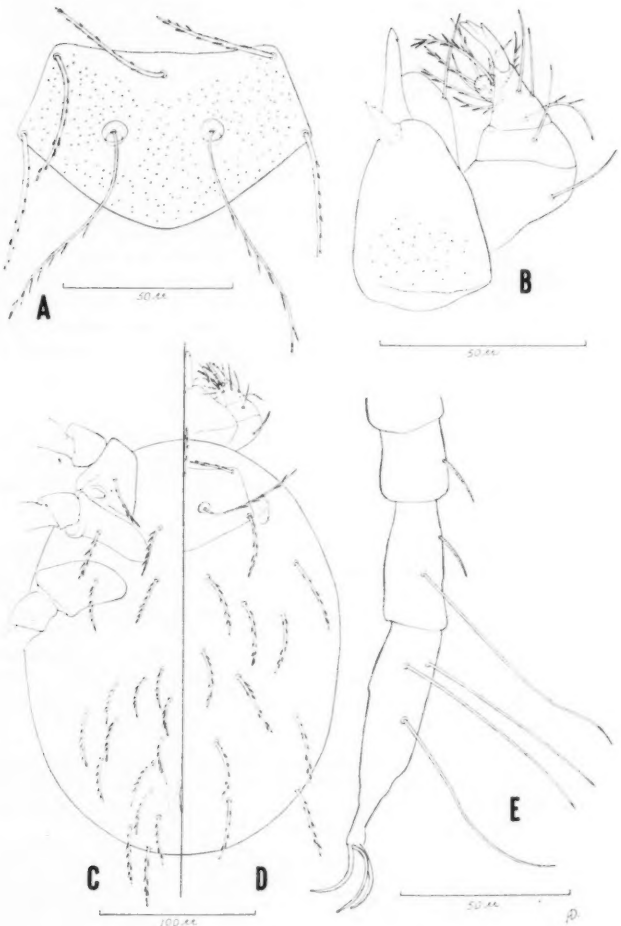


Fig. 8.—*Trombicula varians.* A. scutum, B. dorsal view of gnathosoma, C. venter, D. dorsum, E. leg III showing sensory setae.

Host	Locality	Date	Collection	No. specimens
Melospiza georgiana	Wayne Co., Pa.	3 Aug. 1946	U.S.N.M.	Type+1
			D.U.	1
			R.M.L.	1

Diagnosis.—*T. waynensis* is characterized by 1 mastitibiala III, 2 mastitarsalae III, no mastifemoralae III, feathered femoral and genual palpal setae, nude galeal seta, and barbs along the entire length of the sensillae.

Remarks.—*T. waynensis* was collected by Francis Harper.

DISTRIBUTION

The intensive and systematic collecting of North American chiggers has been restricted to rather limited areas. The few locations in the United States which have been searched diligently are Ravalli and Missoula counties, Montana; Wayne County, Pennsylvania; and Orange County, North Carolina. As might be expected, more species of *Neotrombicula* are recorded for these counties than elsewhere. In general, however, the data assembled here are too fragmentary to give more than an approximation of the distribution of the species. In some cases they are sufficient to postulate probable distribution and to suggest where new records are likely to be obtained. Combinations of distributional patterns, however, are suggested, and most of the species can be grouped conveniently according to one of three such patterns.

Northern group.—*T. harperi, T. microti,* and *T. subsignata* are almost coextensive in distribution, occurring in the mountainous regions of the east, southward into Pennsylvania, and in the west at high elevations as far south as New Mexico.

T. cavicola is also found in both the east and the west. In the east it is recorded only from Reynolds Cave, Kentucky, and in the west from Montana, Washington, Oregon, and British Columbia. These records, while insufficient, do suggest that *T. cavicola* may indeed be one of the northern species.

T. bisignata and *T. waynensis* are eastern species that may belong in the northern group, while *T. browni,* a western species, might be included with the northern species. Two other species *T. varians* and *T. eusignata* may belong either with the northern or the next group of western species.

Western group.—Four species are apparently confined to the region west of the continental divide. These are *T. californica, T. jewetti, T. dinehartae* and *T. alaskensis.* Only the first has been taken from sufficient localities so that its range might be surmised.

Southern group.—*T. whartoni, T. lipovskyi, T. goodpasteri, T. richmondi, T. rohweri, T. carterae, T. farrelli,* and *T. sylvilagi* have been found only in the Mississippi River drainage basin and the eastern states, south of New York. In general, this type of distribution is similar to that of *Eutrombicula alfreddugesi* as shown on a map by Jenkins 1948. Only *T. whartoni* is widely distributed over the area.

Seasonal occurrence.—In general, those species that are in the northern group occur on hosts during the summer months only, those in the western group are found throughout the year, while those in the southern group are found on hosts during the cooler months. While each species appears to have its own seasonal distribution, the general validity of the above statement is demonstrated by table I which summarizes the geographic and seasonal collecting data for each species. *T. cavicola* is the only species that does not fit into the above pattern.

Hosts.—Species of *Neotrombicula* are predominantly parasitic on rodents and lagomorphs. Occasional records from birds have been obtained, but there is insufficient or no evidence to suggest that any species is primarily an avian parasite. Although the type hosts of *T. alaskensis* and *T. waynensis* are birds, the records for each species are based on a single collection. A classified list of hosts and the species occurring thereon is given in table II.

TABLE I.—Summarized geographic and seasonal distribution of North American species of *Neotrombicula.*

Species	Geographic Region	Months Collected
T. bisignata	Northern	July through September
T. browni	Northern	July
T. cavicola	Northern	January through August
T. harperi	Northern	May through August
T. microti	Northern	July through October
T. subsignata	Northern	June through September
T. waynensis	Northern	August
T. eusignata	Northern or Western	August
T. varians	Northern or Western	April
T. alaskensis	Western	June
T. californica	Western	January through December
T. dinehartae	Western	November
T. jewetti	Western	October through March
T. carterae	Southern	December and January
T. farrelli	Southern	December and January
T. goodpasteri	Southern	March
T. lipovskyi	Southern	October through March
T. richmondi	Southern	September through April
T. rohweri	Southern	January and February
T. sylvilagi	Southern	October
T. whartoni	Southern	October through March

TABLE II.—Classified list of hosts and the species of *Neotrombicula* recorded from them.

AVES

Passeriformes

Cyanocitta cristata	*T. whartoni*		*T. whartoni*
Troglodytes aedon	*T. rohweri*	Passerherbulus henslowi	*T. bisignata*
Thryothorus ludovicianus	*T. whartoni*	Melospiza georgiana	*T. waynensis*
Hylocichla ustulata	*T. alaskensis*	Pipilo erythrophthalmus	*T. whartoni*
Seiurus motacilla	*T. subsignata*	Zonotrichia albicollis	*T. whartoni*
Junco hyemalis	*T. harperi*	Unclassified bird	*T. whartoni*

TABLE II.—(*Continued*)

MAMMALIA

Insectivora	
Condylura cristata	*T. bisignata*
Scapanus townsendi	*T. cavicola*
	T. microti
Blarina brevicauda	*T. harperi*
	T. microti
Sorex dispar	*T. microti*
Sorex trowbridgii	*T. jewetti*
Carnivora	
Canis familiaris	*T. whartoni*
Canis latrans	*T. lipovskyi*
Rodentia	
Marmota flaviventer	*T. subsignata*
Citellus columbianus	*T. harperi*
	T. varians
Citellus lateralis	*T. californica*
	T. cavicola
	T. eusignata
	T. harperi
	T. subsignata
Eutamias alpinus	*T. microti*
Eutamias amoenus	*T. eusignata*
	T. harperi
	T. microti
Tamiasciurus hudsonicus	*T. bisignata*
	T. browni
	T. californica
	T. harperi
	T. microti
Sciurus carolinensis	*T. whartoni*
Sciurus niger	*T. whartoni*
Glaucomys sabrinus	*T. microti*
Thomomys monticola	*T. californica*
Thomomys neglectus	*T. californica*
Reithrodontomys fulvescens	*T. lipovskyi*
Peromyscus boylii	*T. jewetti*
Peromyscus leucopus	*T. harperi*
Peromyscus maniculatus	*T. browni*
	T. californica
	T. cavicola
	T. dinehartae
	T. harperi
	T. jewetti
	T. microti
Peromyscus spp.	*T. carterae*
	T. farrelli
	T. lipovskyi
Sigmodon hispidus	*T. whartoni*
Neotoma cinerea	*T. harperi*
	T. microti
Neotoma floridana	*T. lipovskyi*
Neotoma spp.	*T. californica*
	T. harperi
	T. jewetti
	T. lipovskyi
Synaptomys sp.	*T. sylvilagi*
Clethrionomys californicus	*T. jewetti*
Clethrionomys gapperi	*T. harperi*
	T. microti
	T. richmondi
Microtus longicaudus	*T. harperi*
	T. jewetti
Microtus mexicanus	*T. microti*
Microtus oregoni	*T. cavicola*
Microtus pennsylvanicus	*T. bisignata*
	T. goodpasteri
	T. harperi
	T. microti
	T. richmondi
	T. subsignata
	T. whartoni
Microtus richardsoni	*T. microti*
Microtus townsendi	*T. jewetti*
Microtus spp.	*T. harperi*
	T. microti
Pitymys pinetorum	*T. goodpasteri*
Ondatra zibethica	*T. bisignata*
	T. richmondi
Zapus hudsonius	*T. microti*
	T. subsignata
Napeozapus insignis	*T. harperi*
	T. richmondi
Lagomorpha	
Sylvilagus floridanus	*T. lipovskyi*
	T. rohweri
	T. subsignata
	T. sylvilagi
	T. whartoni
Sylvilagus nuttalli	*T. californica*
	T. microti
Ochotona princeps	*T. cavicola*
	T. harperi
	T. microti
Ochotona schisticeps	*T. microti*

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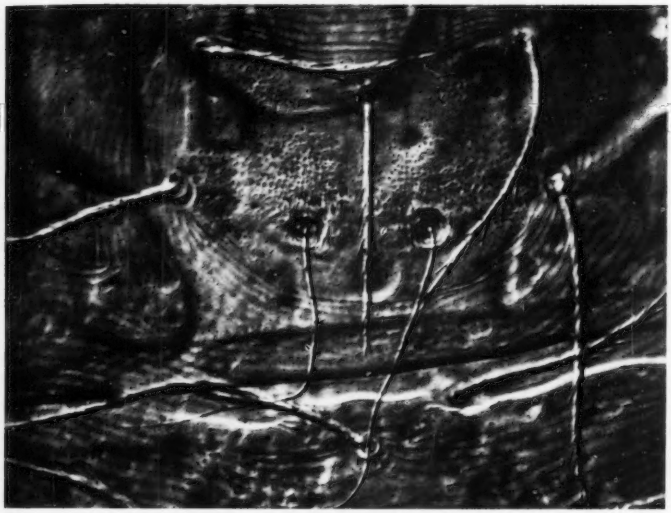
MICROTI

BISIGNATA

Plate 1.—Photomicrographs of scutums of *T. microti* and *T. bisignata*. 565×. N. J. Kramis, photo.



CAVICOLA

FARRELLI

Plate 2.—Photomicrographs of scutums of *T. cavicola* and *T. farrelli*. 565×. N. J. Kramis, photo.

WHARTONI

LIPOVSKYI

Plate 3.—Photomicrographs of scutums of *T. whartoni* and *T. lipovskyi*. 565×. N. J. Kramis, photo.

DINEHARTAE

SYLVILAGI

Plate 4.—Photomicrographs of scutums of *T. dinehartae* and *T. sylvilagi*. 565×. N. J. Kramis, photo.

Variations in the Gonopods of a Xystodesmid Diplopod

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Species of diplopods are separated largely on the structure of the gonopods of adult males. Naturally there have arisen the problems, first, what is the extent of the variation of the gonopods within the range of the species, which is generally comparatively limited, and second, what is the extent of the variation within a clutch? A collection of xystodesmid diplopods received from Mr. Henry Hansen for identification furnished material for studying these problems. It contained 91 specimens of *Nannaria scutellaria* Causey 1942 collected from five sites in the Great Smoky National Park, N. Car.—Tenn. The five sites and the type locality, from which the only previously known specimens were taken, occur within a radius of nine miles.

It was impractical to study color and pattern variation either because many of the sepecimens had been preserved before they had attained the adult color, or because the pigment had dissolved in the preservative. Nor was it practical to compare the specimens carefully as to size because many of those in the adult stage had been collected soon after the last molt, before the exoskeleton had completely hardened, and the body was not fully expanded.

Collection data are given in Table 1. In four of the ten collections all of the 43 specimens were immature and hence of no value for this study. In the remaining six collections there were 48 specimens, all in the adult stage; 17 were males.[1] Two of the collection, 178 and 190 were of particular interest because they provided material for studying variation within two different clutches.

The specimens were dug from soil quadrats of the sizes indicated in Table 1. The larvae undergo all of their development underground, and the adults, also white at first like the larvae, emerge from the soil after the last molt, presumably with the adult colors well developed. Williams and Hefner (1928) have observed a similar life history for an Ohio species. *N. terricola* (Williams and Hefner 1928). Such a life history simplifies the study of variation within a clutch. The egg cluster is deposited underground in a little cavity scooped out by the female. As the larvae pass from one instar to an-

1 Some of the tarsal claws of adult males of the species show a peculiar modification not seen in either the females or in the larval males. The first claw is sharp and simple. Beginning with the second the claws are blunt, thickened, and slightly twisted. Progressing posteriorly they become more twisted. The greatest modification is seen in the fifth (Fig. 1) through the ninth, where each one forms a rough spiral of approximately 360° degrees. Behind this they progressively straighten out and become sharper. Beginning with about the twenty-fifth and continuing through the thirtieth the claws are sharp and simple.

TABLE 1.—Data on *Nannaria scutellaria* Causey 1942. Collected in the Great Smoky Mountain National Park, N. Car.–Tenn.

Number of Collection	Location of Collection	Area of Quadrat	Date of Collection	Number, Sex, Stage of Development
55	6-13-47	Greenbriar Cove	1 M²	10 larvae of 6th and 7th stadia.
168	6-24-47	Greenbriar Cove	1/10 M²	16 larvae of 4th, 6th, and 7th stadia.
622	7- 2-47	Double Spring Gap	1/10 M²	1 adult male, well pigmented.
178	7-20-47	Greenbriar Cove	1 M²	Adult, no pigment, 9 males, 13 females.
190	7-20-47	Greenbriar Cove	1 M²	Adult, no pigment, 5 males, 14 females.
195	7-20-47	Greenbriar Cove	1 M²	14 larvae of 6th and 7th stadia.
684	7-10-47	Ramsey Prong	1 M²	1 adult weakly pigmented male, 2 adult well pigmented females.
685	7-10-47	Ramsey Prong	1 M²	3 larvae of 7th stadia.
681	7-27-47	Cherokee Orchard	1 M²	Adult, well pigmented, 1 male, 1 female.
680	7-25-47	On island near Two-Mile Branch along highway	1 M²	Adult, well pigmented, 1 female.
—	6-21-40	Chimneys	—	Adult, pigmented brown, red keels, 1 male, 1 female.*

* Type specimens.

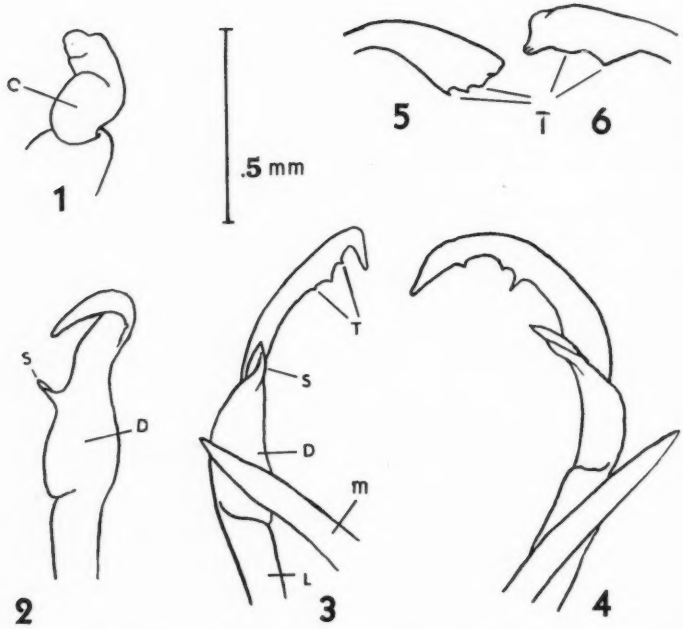
other they move into the soil, but the entire clutch remains within a space of a few cubic inches.

In the genus *Nannaria* (Chamberlin 1918) each of the two gonopods consists of a basal portion on which there are two conspicuous blades, subparallel and anteriorly directed. The lateral or more massive of the two blades, also known as the seminal or main blade, is never coiled, only moderately curved, and seldom passes the midline. The medial blade, also known as the caudal, is shorter and simpler. Specific differences are seen mainly in the structure of the main blade. Species have been described from Tennessee, North Carolina, Ohio, Maryland, and New Mexico.

In the gonopods of the 17 adult male specimens of *N. scutellaria* in this collection, the length of the medial blade, as measured from the tip to the base where it unites with the main blade, was between 1.0 and 1.1 mm. No significant differences in shape were noted. In most specimens the medial blades were subparallel, but in a few they pointed slightly laterally, a condition which may have been caused by the weight of the cover slip.

Other variations in the gonopods are recorded in Table 2. The length of the main blade, as measured along its curvature from the tip to the most posterior point, varied between 1.9 and 2.2 mm.

The curve of the main blade, which occurs about one-quarter of the dis-



Figs. 1-6. *Nannaria scutellaria*. 1.—End of tarsus and claw, *c*, of fifth walking leg; 2. Dorso-medial view of main blade of right gonoped of No. 6, 178; *d*, deflected region; *s*, *spine;* 3-4. Ventral view of main, *l*, and medial, *m*, blades of right and left gonopods, respectively, of No. 9, 178; *d*, deflected region; s, spine; *t*, teeth; 5-6. Ventral view of tips of main blades of right and left gonopods, respectively, of 681; *t*, teeth.

TABLE 2.—Length of Main Blade, Number of Subterminal Teeth, and Angle of Main Blade of the Gonopods of Seventeen Speciuens of *Nannaria scutellaria* Causey 1942 from the Great Smoky Mountain National Park, n. Car.—Tenn.

Number of collection	Number of Specimen	Lgth of Main Blade		No. of Subterminal Teeth on Main Blade		Angle of Main Blade	
		Right	Left	Right	Left	Right	Left
622	1	2.2	2.2	0	0	More obtuse	Obtuse
681	1	2.2	2.2	1	2	Right	Right
684	1	2.2	2.2	1	0	Obtuse	Obtuse
178	1	2	2.1	3	3	Obtuse	Obtuse
	2	2.1	2.1	2	2	Obtuse	Obtuse
	3	2	2	2	1	Obtuse	Obtuse
	4	2	2	1	2	Obtuse	Obtuse
	5	2.1	2	2	2	Obtuse	Obtuse
	6	2	*	1	*	Obtuse	*
	7	*	2	*	2	*	Obtuse
	8	1.8	1.9	3	2	Obtuse	Obtuse
	9	2	1.9	3	3	Obtuse	Obtuse
190	1	1.9	2	1	2	Obtuse	Obtuse
	2	2.1	2.1	2	2	Obtuse	Obtuse
	3	1.9	*	1	*	Widely obtuse	*
	4	2	2	3	1	Right	Right
	5	*	2	*	0	*	Right

* The indicated gonopods were lost by the writer.

tance from the tip, varied from a right angle to a widely obtuse angle. In clutch 178 the angle was obtuse in all specimens. In the other clutch, 190, it varied between right and widely obtuse. In all cases the angle of the left blade was slightly sharper than that of the right blade.

The constriction and deflection of the main blade which occurs about one-third of the distance from the tip showed uniformity throughout the collection. Two views of this region are illustrated in figures 2 and 3. In the type the deflection continues as "two minute appressed spines directed medially." In none of the specimens of this collection could more than one spine be detected in this region. Since the type was an older individual collected while "cruising," the bifid condition may have resulted either from drying or from coitus. The type was not available for reexamination.

The greatest variation was seen in the size, shape, number, and distribution of the minute subterminal teeth on the ventral margin of the flattened main blade. The number varied from none to three and the shape from very sharp to broadly blunt. The shape and number of teeth of a pair of gonopods were not identical, but they tended to resemble each other. Figures 3 and 4 show the teeth from No. 9, clutch 178; this is the type typical for this clutch. There was less similarity between the teeth of the individuals in clutch 190. A less common shape is seen in figures 5 and 6, showing the toothed regions from 681.

SUMMARY

The gonopods of 17 adult males of *Nannaria scutellaria*, collected within a nine mile radius encompassing the type locality, were studied microscopically. While resembling superficially, the gonopods from individuals of two clutches as well as from individuals taken singly, showed slight variation, chiefly in the main blade, which varied as to length, the angle of the curve, and the number, shape, and size of the minute teeth near the free end. Variations within a clutch may be as great as between individuals from different clutches.

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Measurements in the Worker Caste of Two Species of Eciton

(Neivamyrmex Borgmeier) (Hymenoptera: Formicidae)[1]

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With the lack of extensive literature on the subject and the contradictory claims of some authors, it was decided to make a detailed study of preserved material and see whether the worker caste of *Eciton carolinense* Emery and *Eciton nigrescens* (Cresson) shows monomorphism or dimorphism.

Random samples of workers were taken from one colony of *E. carolinense* and one from one colony of *E. nigrescens* in order to determine if the apparent size difference among the individuals of each species were a gradual intergradation representing extremes from a mean or if two definite size groups were involved. It was evident that an overall measurement of each ant would not give an accurate curve due to size changes in the gastric segments; therefore, the overall length of the thorax was used since the size and shape of this body region remained constant.

A problem encountered with *E. nigrescens* was that the wiry condition of the body and legs prevented the ant from lying on its side. To overcome this obstacle all samples of this species were boiled in 3% KOH on a steam bath for 15 minutes, washed, and placed in 30% ethyl alcohol.

The measurements were made by using a line reticle mounted in a binocular microscope. All the measurements were made to 1/100 mm.

A group of 252 ants from a colony of *E. carolinense* which was collected near Gatlinburg, Great Smoky Mountains, Tennessee (April 30, 1949, A. C. Cole) was measured and clearly gave a monomodal curve. The extreme minimum was 0.52 mm and the extreme maximum was 1.40 mm; the mean being 0.87 mm. (Fig. 1, A.)

A total of 244 ants from a colony of *E. nigrescens*, collected in Monroe County, Tennessee (May 24, 1947, A. C. Cole and J. W. Jones) was measured and a monomodal curve was obtained. The extreme minimum in this group was 1.14 mm and the extreme maximum was 1.84 mm, the mean falling at 1.42 mm. (Fig. 1, B.)

Conclusions regarding size range are obvious. If dimorphism in the worker caste were present, a bimodal curve would have been obtained; however, the workers of each species showed a definite normal frequency curve.

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3 Professor of Entomology, University of Tennessee.

There appears to be no structural differences among the workers of either *E. carolinense* or *nigrescens* by which individuals could be separated into two or more definite groups. The authors have not observed any contrasting behavior patterns among the workers of either species.

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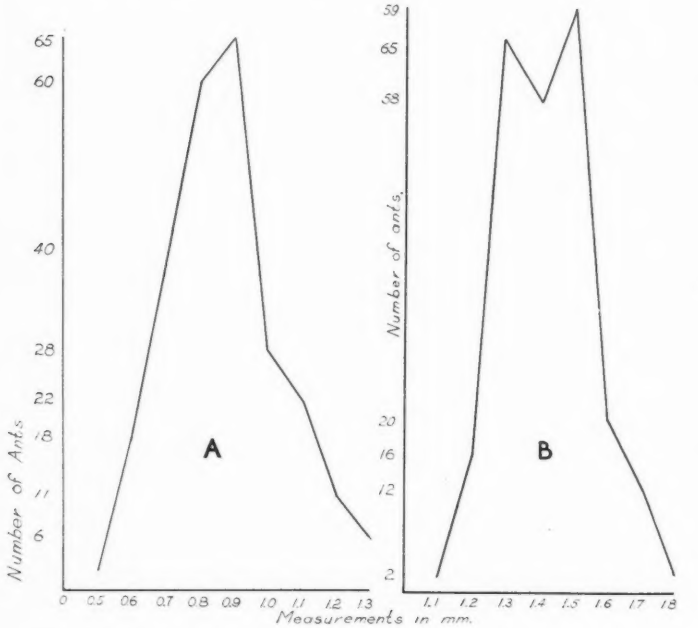

Fig. 1.—Graph A shows the monomodal curve obtained from thoracic measurements of 252 workers from a colony of *Eciton carolinense* Emery; graph B shows the same type of curve obtained from thoracic measurements of 244 workers from a colony of *E. nigrescens* (Cresson).

Additions to the Description of Plumatella repens furcifer Jullien

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Introduction

In 1885 Jullien described in a casual manner a new variety of *Plumatella repens* in which "la plupart des zooecies possédent une crête anale bifurquée sur le fond zooecial" (Jullien, 1885) and to which he assigned the variety name *furcifer*. In addition to the above primary diagnostic characteristic the only other morphological data Jullien gave were that the new variety had 50 tentacles, possessed yellow lines on the stomach, and was encrusted with hyaline, quartzite grains. Apparently Jullien's specimens did not contain statoblasts in spite of the size of some of his colonies and their abundance for he made no mention of them. Such a limited number of characteristics leaves much to be desired in attempting to separate variety *furcifer* from the numerous other *P. repens* varieties particularly in view of the facts that the taxonomic subdivision of *P. repens* is at best complicated and that the varieties are frequently not sharply delineated one from the other in the literature. As Rogick and Brown (1942) pointed out, this state of affairs is largely due to a scarcity of information on both anatomical and physiological aspects of most of these varieties.

The finding of *Plumatella repens furcifer* Jullien, in good fruiting condition offers an opportunity to add certain details of taxonomic value to the heretofore scanty description. As fas as I know this variety has been reported in the literature only once subsequent to Jullien's initial description and prior to this present account. Dr. Mary Rogick reported collecting it at 3 stations in Lake Erie, the specimens from which were likewise devoid of statoblasts (Rogick, 1935a and *in litteras*).

The specimens upon which this report is based were collected by the writer from the southwest shore of Lake Cayuga near Ithaca, N. Y., in July 1943. The material contains an abundance of statoblasts which permits a more detailed description as well as measurements to be made of this variety. Colonies were scraped from the bottom of stones taken a short distance from shore in less than 4 feet of water and preserved immediately.

The writer is indebted to Dr. Mary Rogick for her comparing these specimens with those she collected from Lake Erie as well as for numerous generous considerations.

DESCRIPTION AND DISCUSSION

Colonies of *P. repens furcifer* vary greatly in size. Jullien reported some, which were collected from the under surface of rocks, to be the size of two hands. The largest colony collected from Lake Cayuga is 2.5 by 1.5 cm.; most are even smaller and more fragmentary. The zooecia in the larger colonies form an open meshwork with the individuals 4 or 5 abreast near the center (Fig. 10) ranging to single or double zooecial strands at the periphery. Many colonies consist merely of a loose network of the double or single zooecial strands. The colonies are entirely adherent to the substratum which has been reported as plant (Jullien, 1885) as well as rocks; all from Lake Cayuga came from the under side of small rocks. Grossly the colony color (preserved material) is dark gray with scattered dark brown and black spots due to the presence of statoblasts.

The individual zooecia also vary in size and shape. Table 1 gives a summary of dimensions for a few measured characteristics. The width tends to be greatest in the region of the aperture where the recorded measurements were made. Due to the fact that the septa do not show in the frontal aspect in zooecia which retain the polypides intact, measurements of zooecial length were taken from one end of the orifice to the corresponding point on the next zooecium in line. The zooecial length varies considerably as can be seen from the table. Thus in some colonies the zooecia are short and appear crowded. This condition is characteristic of the central zooecia of some colonies where the longer zooecia are located at the periphery. The shape of the individual zooecium in cross section is semicircular, approaching a broadly-rounded triangle in some few cases. The volumetric shape is that of a semicircular cylinder with the aperture and its base protruding near one end at an angle of from 45° to 90°. Incomplete septa separate the individual zooecia and allow the endocyst of one polypide to connect with that of its successive neighbors. The bottom of the zooecium is flat and entirely adherent to the rocks. In many cases the bottom remained behind on the rock from which the colony was scraped (as in Fig. 6). The aperture is oval in outline; its dimensions are given in Table 1. Immediately proximal to the aperture the ectocyst is transparent and resembles a collar (Figs. 5 and 6) which tends to be absent from old, decrepit zooecia (Fig. 1) probably due to external wear on the colony. Confluent with and extending backward from this transparent collar the ectocyst is similarly transparent in the form of a band which bifurcates in some zooecia; it was upon this latter feature that Jullien based the separation of his new variety, *furcifer*.

The status of a keel or furrow in *P. repens furcifer* presents a problem. To begin with, Jullien (1885, pages 100 and 111) stated that he used the term anal crest (*crête anale*) for what had been previously called furrow and keel by Allman. From his statement one is not certain if Jullien used the term anal crest to include either or both a depression (furrow) and an elevation (keel). Furthermore Jullien (1885, page 111) pointed out that the anal crest (not specifically applied to variety *furcifer*) is extremely variable in its presence and transparency. In his opinion it could no longer be considered a

specific taxonomic characteristic due to its presence and complete absence on different individuals of the same colony. Unfortunately Jullien's one illustration of *furcifer* is a surface view which does not bring out the presence of either a keel or furrow with certainty.

Dr. Rogick (1935a) referring to variety *furcifer* wrote of "the bifurcated crest *or* furrow which occurs on a number of the zooecia in the colony (italics mine). However, in a key to numerous varieties of *P. regens* she (Rogick, 1935b) characterized *furcifer* as possessing a furrow but not a keel.

In the Lake Cayuga specimens there is no well developed keel on any of the zooecia examined; there is present a very slight keel on some of the individuals which is evident if cross sections are made. Neither is there a well defined

TABLE 1.—Measurements of *Plumatella repens furcifer* Jullien*.

	Maximum	Minimum	Average	Number of Readings
Zooecia				
Width	0.685	0.447	0.544	25
Length	2.086	0.924	1.668	15
Orifice				
Length	0.507	0.328	0.402	15
Width	0.417	0.238	0.331	15
Floatoblasts				
Total length	0.361	0.299	0.316	25
Total width	0.258	0.216	0.229	25
Total thickness	0.139	0.093	0.116	25
Capsule				
Length	0.247	0.196	0.217	25
Width	0.196	0.165	0.178	25
Float, dorsal				
Length**	0.113	0.082	0.098	50
Width	0.072	0.046	0.057	50
Float, ventral				
Length	0.086	0.052	0.074	50
Width	0.052	0.031	0.042	50
Sessoblasts				
Total length	0.484	0.422	0.450	15
Total width	0.412	0.371	0.387	15
Total thickness	0.175	0.124	0.145	15
Capsule				
Length	0.453	0.381	0.418	15
Width	0.381	0.340	0.356	15
Float diameter	0.026	0.010	0.013	30

* All measurements are in millimeters and were made with the use of an ocular micrometer.

** By float length is meant its radius at one end of the floatoblast.

furrow discernible. The presence of a keel and/or furrow is hardly apparent enough in this material to warrant the use as features distinctive of variety *furcifer*. What is present on these specimens and what corresponds to the well marked feature of Jullien's one illustration of *furcifer* is a band-like region of ectocyst free from encrustation extending back from the transparent collar of the aperture and occupying the position of a keel or furrow if one were present (Figs. 1 and 5). Most of the zooecia in the colony possess this feature; it is bifurcated distally in many cases where it is present. In view of the discrepancy or apparent wide variation of the keel and/or furrow situation in *P. repens furcifer* it might be better to substitute the presence of the transparent band of ectocyst which bifurcates in many cases for the former characteristics in distinguishing this variety from other *P. repens* varieties.

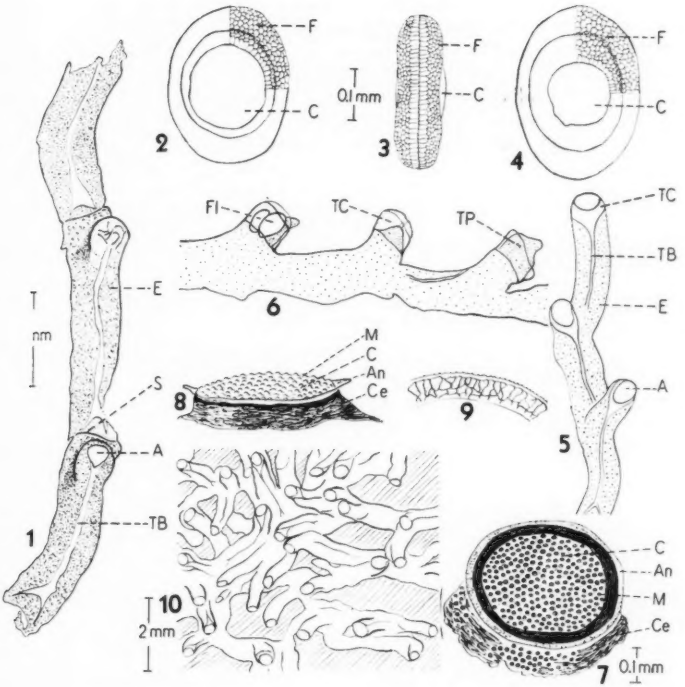
The ectocyst is composed of two layers, an outer delicately encrusted membrane and an inner transparent tougher layer. The outer layer is the thinner one and is almost entirely encrusted with minute hyaline or siliceous particles except for the region just behind the orifice and the band extending back from the aperture on the frontal aspect of the zooecium. Here the outer layer of ectocyst is not encrusted but rather is transparent and allows the darkly colored inner layer to show through. The transparent band corresponds in extent to that of Jullien's figure of variety *furcifer* and as he stated, bifurcates in some zooecia of the colonies. This latter characteristic shows best on the larger zooecia and on those in which the polypides have been removed (Figs. 1 and 5).

The inner layer of ectocyst is thicker, transparent, more rigid than the outer one, and is light amber in color. As noted above, where the outer layer is not encrusted, the color of the inner layer is evident from the exterior. The two layers are firmly united except in old and worn zooecia where they can be peeled one from the other. As far as could be determined, only the inner layer forms the partial septum between successive zooecia.

Due to the nature of the preserved material no attempt was made to study any of the finer anatomical points concerning the polypides. In most cases the tentacles are retracted. Jullien (1885) and Rogick (1935a) stated the tentacle number in their specimens to be 50. An attempt was made to count the tentacles on a few polypides to compare with results of these two workers. In each of the 3 cases results below 50 were obtained: 30, 41, and 41. There is a good possibility that the tentacle number varies and that it is lower than 50 in some cases.

Fortunately both sessoblasts and floatoblasts (Rogick, 1943) are present in the Lake Cayuga material. As a result, these two elements can be described for this variety for the first time. Results of measurements on the floatoblasts (Figs. 2, 3, and 4) are given in Table 1. Both immature and mature floatoblasts are present, however only mature ones were measured. The shape of both capsule and entire floatoblast is oval, with an average length of 0 316 mm. and width of 0.229 mm. The annulus is well developed and covers more of the capsule on one (i.e. the dorsal) side than on the other. These floatoblasts resemble, as far as measurements are concerned, those of *P. repens minuta Toriumi* (Toriumi, 1941). Sessoblasts (Figs. 7 and 8) are present in

great numbers. They occur singly or in rows of from 2 to 5, always on the bottom and frequently in company with floatoblasts in the same zooecium. When in a group they are cemented tightly together in a row. The color of mature sessoblasts is very dark brown or black, that of immature ones is light brown. They are broadly oval, almost circular, and possess a small vestigial



Figs. 1-10.—1. Frontal aspect of three old decrepit zooecia; 2. Ventral view of floatoblast; 3. Edge view of floatoblast with dorsal side to right; 4. Dorsal view of floatoblast; 5. Surface view of three normal zooecia; 6. Side view of three normal zooecia. The bottom is irregular due to its having been scraped from the rock surface; 7. Dorsal view of mature sessoblast. The mammillae are possibly slightly larger and perhaps less numerous than they should be in actuality; 8. Side view of mature sessoblast; 9. Enlarged view of vestigial annulus of sessoblast; 10. Dorsal aspect of central portion of a colony to show arrangement of zooecia.

All figures except 5 and 9, were drawn with the aid of a camera lucida. Magnifications: Figs. 2 and 4, same as fig. 3; fig. 6, same as fig. 1; fig. 8, same as fig. 7 (see scales). Abbreviations: A—aperture, An—annulus (vestigial), C—capsule,Ce—cement, E—encrusted ectocyst, F—float, Fl—floatoblast, M—mammilla, S—septum, TB—transparent band, TC—transparent collar, TP—tip of polypide.

annulus. This annulus lacks typical air cells but possesses reticulated markings which can be interpreted as vestiges of air cells. It is minutely serrated when magnified greatly. The free surface of the sessoblast exhibits prominent mammillae. Cement substance is abundant and black. Sessoblasts dissected from the zooecium are frequently covered over the top with a thin transparent white membrane which can be peeled from it.

SUMMARY

A third report (second for N. America) on the occurrence of *Plumatella repens furcifer* Jullien, is made. Various morphological data are presented in an effort to distinguish more clearly variety *furcifer* from other varieties of *P. repens*. Floatoblasts and sessoblasts are described for the first time.

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The Vertebrate Fauna and Geologic Age of Trinity River Terraces in Henderson County, Texas

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ABSTRACT

An attempt is made to correlate the various stratigraphic units of the Pleistocene in Henderson and adjoining counties to related up-dip terrace deposits with the equivalent formations of the Gulf Coastal Plain and to determine the age of these terraces as compared with the glacial deposits in the glaciated states.

The highest of a series of 3 alluvial terraces associated with the present Trinity River in the area under consideration in east-central Texas is especially well-developed and offers the possibility of serving as a standard unit for correlation of other stream deposits in the Texas coastal plain. The 3 terraces are herein designated, from highest to lowest, as Trinity Terrace, Trinidad Terrace, and Power Plant Terrace. An interesting assemblage of vertebrate fossils containing 17 genera, including a new species of *Megalonyx*, collected from numerous sand and gravel pits located on the highest terrace, is described.

On the basis of paleontologic and stratigraphic evidence it is concluded that all 3 of the terrace deposits were laid down during the Wisconsin stage of the Pleistocene. It is suggested that Trinity Terrace is the up-stream equivalent of the Lissie formation; that the Trinidad Terrace may be equivalent to the Beaumont formation; and that the present flood plain represents practically all of the Recent time.

INTRODUCTION

During the period from March, 1939 to October, 1941, the junior author was employed as a supervisor of a paleontologic-mineralogic survey, a Works Projects Administration project sponsored by the Bureau of Economic Geology of the University of Texas, Austin, Texas. During that time the junior author became interested in the several fine collections of Pleistocene fossils assembled from terrace deposits along many of the major streams and from coastal plain deposits in the region bordering the Gulf of Mexico. One of the largest and most interesting of the terrace assemblages came from several sites located on a high terrace of the Trinity River in Henderson, Navarro and Freestone counties.

The division and correlation of the various stratigraphic units of the Pleistocene, i. e., correlation of the up-dip terrace deposits with the equivalent formations of the Gulf Coastal Plain, and the age of these terrace deposits in the glaciated states of the United States has been, and still remains, one of the most perplexing problems in the late Cenozoic stratigraphy. Realizing that proper study and intrepretation of the numerous data being assembled by the paleontologic-mineralogic survey could shed considerable light upon many of the complex problems of Quaternary stratigraphy, the junior author in 1940, in collaboration with Glen F. Evans, assistant geologist with the Bureau of

Economic Geology of the University of Texas, Austin, Texas, planned a study of the Quaternary deposits of Texas.

Since this study was not completed, the writers present this paper as a partial answer to a small portion of the overall problem. We realize that the results presented here leave much to be desired. We appreciate the need to broaden the field of study and to find means to more exactly relate vertebrate fossils to their true geologic age.

Along the Trinity River is a series of well-developed terraces lying essentially parallel with the course of the present stream valley. The highest of these terrace deposits is especially well developed, attaining a thickness of 50-55 feet and a width of from 1 mile to more than 3 miles. This high terrace is an important stratigraphic unit in that it covers a large area and offers the possibility of serving as a standard unit for correlation of other stream terraces of the Texas coastal plain.

Numerous sand and gravel pits located on these terraces in Henderson, Navarro and Freestone counties have yielded an interesting assemblage of well-preserved vertebrate fossils, there being a total of 17 identifiable genera. An attempt has been made to use both paleontology and stratigraphy to determine the geologic age of the terraces. The fossils were studied in some detail in an effort to ascertain whether the assemblage as a whole, or any of the individual genera or species in the assemblage, was diagnostic of any particular sub-epoch of the Pleistocene.

The area with which this report is concerned is in east-central Texas in Henderson, Freestone and Navarro counties. (See index map.) The greater part of the work was done in Henderson County, the county seat of which is Athens, located about 68 miles southeast of Dallas. As may be seen by the index map, the Trinity River forms the western boundary of Henderson County, and the Neches River forms the eastern boundary. A high terrace between those rivers, centered in the vicinity of Trinidad, forms the chief area of study. The majority of the fossils came from sand and gravel pits on this terrace.

The terraces along State Highway 19 on the Navarro County side of the Trinity River were also studied. In addition to the fossils found in the sand and gravel pits mentioned above, other fossils came from the John W. Carpenter farm in Freestone County. The sites of discovery are on a high terrace along the Trinity River, located about 1.5 miles west of the river and 100 yards south of State Highway 22. Other fossils came from cuts made to secure earth to build levees on Valley Farms about 23 miles northeast of Corsicana, in the northeastern part of Navarro County.

QUATERNARY DEPOSITS

Pleistocene and Recent deposits found in Henderson and adjoining counties include scattered gravels which occur as a thin mantle in isolated patches on the higher divides and as alluvial deposits associated with present streams. Those latter deposits embrace terrace gravels that represent the alluvial fill of the valleys at a previous higher level. Similarly, alluvial sediments underlie the flood plains, "bottom lands," and occupy the channels themselves.

This investigation is concerned with the deposits present in an area bordering the Trinity River and its tributary, Cedar Creek, in the immediate vicinity of Trinidad. The character, distribution, origin, fauna, and correlation of the sediments with other Quaternary deposits of the Texas coastal plain and with glacial deposits outside the area are discussed and evaluated.

Historical Resume: A brief statement regarding names used and some of the work already done on Pleistocene deposits, especially those of streams, in the Coastal Plain of Texas, is in order.

McGee (1891) described the Pleistocene deposits of the Atlantic slope under the name of Lafayette formation. The name, Lafayette formation, has been extensively used and was, in fact, adopted in many text books and used in most early geological reports as a "catch all" for all types of surface deposits, ranging from Tertiary to Recent in age. Dumble (1918) used the name . . .

> for those deposits of gravels, sands, and clays often characteristically orange color, which occupy the belt between the Fleming to the north and Coast clays on the south, between the Sabine and Brazos, their stratigraphic position being between the two formations named.

As used by earlier writers, the Lafayette included the Lissie, Leona, and Uvalde or Reynosa formations of recent reports. Sellards, Adkins, Plummer (1932).

Fig. 1.—Outline map of Texas showing the location of the area covered in this paper.

To upland gravel deposits of central and south Texas, Hill (1891), applied the name Uvalde. Later in that year, Hill and Vaughn (1891) described the Uvalde as follows:

> In the Rio Grande plain lying off the foot of the Balcones escarpment, from San Gabriel to Devils River, and extending coastward many miles, there is a remarkable geologic formation or series of formations to which the name Uvalde has been given. It consists of a vast deposit of gravel composed almost entirely of rolled flint pebbles, with occasional pieces of limestone, partially embedded in a matrix of chalky marl and clays. Most of these materials have been derived from the decay of the Edwards limestone of the plateau, and spread like a mantle over the lower plain. . . . It caps the higher divides in the Rio Grande Plain, and constitutes the highest terrace level in the Canyon valley of the steam.

The following is taken from Plummer's (1932) discussion of Uvalde deposits:

> The gravels of the Uvalde deposits occur on the stream divides. . . . They rest upon formations from Lower Cretaceous to Miocene. . . . The gravel is distinguished from the Lissie and later stream terrace gravels by its higher topographic position on divides and interstream ridges and by the larger size of its cobbles and by the larger proportion of chert, and by its smaller proportion of calcareous material. . . . Since the Uvalde is older than these early Pleistocene stream terraces, it is placed in the late Pliocene or oldest Pleistocene and correlated with the upper Pliocene sand of the eastern Gulf Coast or basal Lissie of south Texas.

Weeks (1941), correlated the Uvalde with the period of ice retreat following the Wisconsin 1 or Iowan of the Pleistocene epoch.

To terrace deposits along the principal streams in Texas, Hill and Vaughn (1891) gave the name Leona formation. At the same time they described the Onion formation of Travis County and divided the Colorado River terraces at Austin, Travis County, Texas into the following divisions: Asylum terraces, 215, 205, and 195 feet above the river; Capitol terraces, 130 and 105 feet above the river; and Depot terraces, 80 and 60 feet above the river.

Hill (1901) correlated the Leona and Onion Creek deposits with the Asylum as a stratigraphic unit and correlated it with the interglacial stage following Wisconsin 2 or Tazwell.

To all sands and gravels above the Oakville and Lagarto and below the Beaumont clay, in the vicinity of Lissie, Wharton County, Texas, the name Lissie formation was applied by Deussen (1914).

According to Plummer (1932), the Lissie includes the Pleistocene strata exposed north of the Beaumont Plain and south of the Hockley Ridge and the rolling topography of the Pliocene terrain. It occupies a belt about 30 miles wide parallel to the present coastal plain at a distance of about 50 miles from the coast, the beds extending from Sabine River to the Rio Grande. Terrace deposits of equivalent age extend up the principal streams and overlap older deposits. The Lissie is composed of thick beds of sand containing lentils of gravel and is interbedded with clay and silt. The deposits originated during the Glacial epoch at a time when there was increased rainfall. The sediments on the outcrop are partly continental in origin: were laid down as flood plain deposits along the main lines of drainage as they spread out over the flat coastal plain and as deltaic deposits. Weeks (1941) correlated the Lissie with the

interval of glacial retreat following Wisconsin 3 or Cary stage of the Pleistocene.

To dark colored clays lying unconformably above the Lissie in the vicinity of Beaumont, Jefferson County, Texas, Hayes and Kenedy (1903) gave the name Beaumont clay. Plummer (1932) states that it occupies a belt about 40 miles wide, nearly 10 to 15 miles from the coast, all along the coast of Texas.

Apparently Beaumont sediments were deposited largely by rivers in the form of natural levees and deltas which coalesced by shifting of the river mouths along the coast and to a lesser extent by marine and lagoonal waters in the bays and embayments between stream ridges and delta banks. An excellent discussion of the deltaic concept of the younger coastal plain deposits has been contributed by Barton (1930). The Beaumont is correlated by Weeks (1941) with the interval of ice retreat following the Wisconsin 4 or Mankato advance.

Sellards (1940) and Evans discussed some stream terraces in Bee, Goliad, and Refugio counties in south Texas and, on the basis of fossil vertebrates and stratigraphy, correlated the highest terrace with the Beaumont formation. To this high terrace they gave the name Berclair.

A brief discussion of the area under consideration in this study was given by Sellards (1941) in a paper dealing with the occurrence of carved stone images in Trinity River deposits.

Stream Terraces.—Under this heading are included 3 alluvial terrace deposits that are definitely associated with the present stream and present flood plain. The terraces are younger than the upland gravels and older than the flood plain deposits. The name Trinity Terrace is applied to the highest and

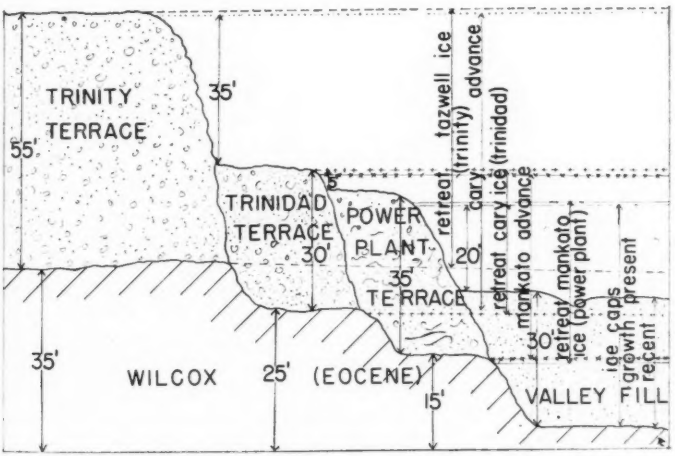

Fig. 2.—A cross-section of the terraces discussed in this paper showing an ice advance and retreat for each terrace.

most extensive of these deposits; to the terrace next below is given the name Trinidad Terrace; and the terrace just above the present flood plain, on which the power plant of the Texas Power and Light Company is located, is designated as Power Plant Terrace. In this area all 3 of the terraces rest upon the Wilcox group of Eocene age.

Trinity Terrace.—This is the oldest, highest, and most extensive of the 3 Trinity River terraces in this area. It is an important stratigraphic unit in that it covers a relatively large area and offers the possibility of serving as a standard for correlation of other stream terraces of the Texas coastal region. Where least affected by erosion or the accumulation of aeolian sands, it attains a thickness of 50 to 55 feet and a width of from 1 to more than 3 miles. As determined by bore holes and exposures, the bed rock upon which the sands and gravels rest is about 35 feet above the bed rock of the present flood plain. For all 3 terraces the base, as well as the top, rises in each successively older terrace, and it is possible to identify a particular terrace by the position of the bed rock as well as by the surface level.

The majority of the fossils discussed later in this paper came from sand and gravel pits located on this terrace in the area north of Trinidad between the Trinity River and Cedar Creek. Several sand and gravel pits and natural exposures offered a good opportunity for finding fossils and for studying the deposits.

The discussion of the lithology which follows is based on observations made at, and a study of samples taken from, the Wharton pit located ¼ mile north of State Highway 31 on the east side, and approximately 250 yards from the Trinity River; the Leo Boatwright pit, 2.5 miles northeast of Trinidad on the Leo Boatwright farm; and the Bishop pits which face the valley of Cedar Creek about 1.5 miles northeast of the Boatwright pit, about 3.5 miles northeast of Trinidad, or 5 miles west of the town of Malakoff, on the Judge Bishop farm. A vertical section of from 20 to 35 feet is exposed at each of these localities.

The Trinity Terrace is made up of stream-laid sands and gravels with smaller quantities of clay and silt. The sands range from fine to coarse; the larger fragments range from granule to cobble in size, with pea-size predominating. Some quartzite cobbles 6 to 8 inches in diameter are scattered through the finer materials. At the Wharton pit, numerous angular blocks, up to 20 feet in diameter, of a friable, calcareous, ferruginous sandstone (Wilcox) that show no signs of having been transported by water are scattered at random through the lower part of the section. Images of the human head in round "concretions" of this type of sandstone, found in one of the Bishop pits, have been described by Sellards (1941).

Irregular shaped calcareous concretions, ranging from the size of a pea up to 3 or 4 inches in diameter, are present throughout the section. Limy nodules are especially abundant in a fine sandy zone, about 10 to 15 feet below the surface, at the Boatwright pit. These probably are the result of alluviation of the materials above.

In places there are numerous rod-like structures of sand, 1 to 3 inches in diameter, which probably represent burrow fillings. Some clay balls were

observed in the sandy zones, and there are occasional clay lentils from 2 to 4 inches in thickness. Lenticular layers of a hard, yellowish, calcareous sandstone are present at different levels. In places there are thin conglomeratic zones where pea-size gravels are held together by calcium carbonate. The better, unworn, vertebrate fossils are found in pockets of fine sand, silt and clay near the base of the deposit. Bone fragments, many of which are water worn, and worn Cretaceous shells are abundant. A few worn Eocene shark teeth were observed. Fragments of silicified wood are common.

A zone of fine sand, present at the top in some places, is possibly of aeolian origin. Beneath this upper sandy zone, stream crossbedding is developed to a remarkable degree in many places.

The majority of the materials making up Trinity Terrace are silicious; however, limestone and ferruginous gravels are fairly plentiful. A considerable amount of finely divided calcareous material is present, as all samples tested effervesced freely in diluted hydrochloric acid. In general, the color ranges from light yellow to brown due to the presence of considerable ferruginous material.

Trinidad Terrace.—Most of the northern part of the town of Trinidad, including the railway depot, is built on this terrace. Usually, only isolated remnants of the terrace deposits have escaped destruction by later stream meandering. These may be found on either side of the river, but seldom on both sides at opposite points. The bed rock level of the terrace is approximately 25 feet above the level of the rocks underlying the present flood plain. The alluvial fill is about 30 feet thick and is composed of materials similar to Trinity Terrace, but with a larger per cent of silt and clay. Fragments of bone and worn Cretaceous shells are abundant, but no identifiable specimens were obtained from this terrace.

Power Plant Terrace.—The southern part of the town of Trinidad and the power plant of the Texas Power and Light Company, south of Trinidad, is built on this terrace. About ½ mile south of the railroad depot at Trinidad, it becomes confluent with a terrace of the same level on Cedar Creek. Both Trinidad Terrace and Power Plant Terrace may be observed along State Highway 31 on the west side of the Trinity River. The bed rock is about 15 feet above that of the present flood plain. The height of its surface is approximately 20 feet above the surface of the flood plain, and the alluvial fill is about 35 feet thick.

Flood Plain.—The present flood plain ranges from about 0.7 to a little more than 2.5 miles in this region. The present channel, which is an alluvial fill, follows a meandering course from one side of the flood plain to the other. Soundings made for the bridge foundation on State Highway 31 show that the thickness of the flood plain deposit is about 30 feet.

Upland Gravels (? Uvalde Formation): Some of the higher upland ridges are mantled with scattered gravels. The pebbles are of gray, white and pink quartzite, milky and smoky quartz, and some flint and jasper. No calcareous material of any kind was found in the sample studied. The gravels

range from the size of a pea up to 2 or 3 inches in diameter, with the smaller sizes predominating. Mixed with the pebbles are occasional fragments of silicified wood. In places these gravels appear to be undisturbed and in their original place of deposition; in other places erosion of the underlying soft Tertiary rocks and leaching of any cementing material that may have held the gravels together has undoubtedly caused them to be let down from an original higher position.

In discussing similar deposits in Leon County, Texas, Stenzel (1938) says:

> It may be that originally the region was largely covered by an extensive gravel sheet which was lying on a planed surface of the beveled Tertiary beds. This sheet has been largely destroyed and the present gravel beds constitute merely remnants. . . . Whether there was an extensive original gravel sheet and how thick it was is an open question. . . . It is also possible that some of the upland gravels belong to high river terraces that may be considered younger than typical Uvalde gravels.

Distribution.—Lack of time prohibited any attempt to trace these terraces in either direction outside of the area studied. However, excellent terrace development along the Trinity River has been observed by the writers at points upstream and downstream from Henderson County. Stenzel (1938) mentions that terraces are well developed and extensive along the Trinity River between Oakville and Upper Keechi Creek and between Raymond and Commerce in Leon County. According to Dumble (1918) . . .

> three terraces, including the present flood plain, are well developed on the Trinity, at Westmoreland and Clarke bluffs (western Houston County). The height of each will average close to twenty-five feet. The prairie level terraces are still higher and there are traces of a still lower one being developed on the present flood plain.

He also mentions terrace development at several other places downstream from Houston County.

Origin of the Terraces.—Alluvial terraces represent erosional remnants of a previous, higher valley and may be accounted for by the meandering and shifting streams slowly degrading valleys which had previously been aggraded. A change from deposition to erosion may result from one or more of the following causes and may be related to either uplift or climatic changes, or both.

> (1) A decrease in the load of a stream may cause it to cease depositing and begin eroding. This may result from the cessation of headward erosion. On the other hand, as the valley lengthens, much of the load may be dropped farther and farther in the upstream direction, and after the load is lost degradation may take place on its lower flood plain.
>
> (2) As the result of uplift, the velocity of a stream may be so increased that down-cutting replaces deposition. Should a region experience successive uplifts which keep the stream degrading its former flood plain, and never allow it to reach a graded condition, there should be equal development of terraces on the 2 sides of the valley. Of course, a lowering of sea level with respect to land will produce the same effects as rising of the land with respect to sea level.
>
> (3) An increase in the volume of water carried by a stream without a corresponding increase in load would cause a change from aggradation to entrenchment. This may result when a moist climate follows a dry one, or from stream piracy.
>
> (4) A degrading stream which suffers a decrease in volume so that it can no longer occupy the full width of its valley may cut a narrow valley in the older one.

There must be a period of valley alluviation preceding the formation of alluvial terraces. Alluviation may result from the building of a delta at the mouth, thereby lengthening the stream and reducing its gradient so that it is necessary for it to build up the bed to maintain grade and from deposition in the middle or upper reaches of a graded stream.

Terraces are well developed along all of the principal streams flowing across the Texas coastal plain into the Gulf of Mexico. A rise of sea level permits the building of deltas and gradual headward alluviation. A lowering of sea level would rejuvenate these streams and cause them to begin entrenching in a headward direction. It is likely that repeated coastward tilting of the coastal plain has aided rejuvenation and entrenchment of these streams at various times. However, the opinion of the writers is that repeated advances and retreats of glacial ice during the Pleistocene had more to do with the formation of these alluvial terraces than anything else.

It seems reasonable to suppose that warm Gulf winds coming in contact with the ice sheets and valley glaciers to the north as the ice advanced and retreated caused considerably more rainfall in the Texas region than at present. A greatly increased rainfall would have produced larger streams capable of bringing down great loads of all sizes of debris.

During the glacial advances, when millions of cubic miles of water were locked up in the form of ice, sea level would have been lowered sufficiently to cause the streams to degrade their channels. With melting and retreat of the ice, during an interglacial stage, sea level would have been raised and the streams would have begun alluviating their channels. Thus, the materials composing the terraces would have been laid down during an interglacial stage, and the terraces, in a topographic sense, would have been produced during a glacial stage.

In the case of the Trinity River, there was marked entrenchment following each period of valley alluviation. The rejuvenated stream not only cut down through from 30 to more than 50 feet of its own fill, but also several feet into the underlying bed rock. Each terrace deposit lies upon beveled bed rock. In the area studied, the total amount of downcutting during the glacial age following Trinity deposition was approximately 65 feet, of which 55 feet was through alluvium and 10 feet in bed rock. Following Trinidad deposition the entrenchment amounted to about 40 feet, down through 30 feet of alluvial fill and 10 feet of bed rock. After Power Plant time the channel was lowered some 50 feet, through 35 feet of valley fill and on downward another 15 feet into bed rock.

The excavation done after Power Plant time may correspond to a period of marked growth of the existing ice caps together, possibly, with uplift of the interior. Then the 30 feet of alluvium constituting the present flood plain may represent alluviation of the deeply entrenched valley following recession of existing ice sheets. A delta is being built at the mouth of the Trinity River today, and so long as the land-sea relationship and other factors remain constant, alluviation of the present valley will continue progressively in an upstream direction. Power Plant Terrace and the present flood plain may represent much of Recent time.

Correlation and Age.—According to Stenzel (1938) upland gravels in Leon County are traceable westward into upland gravels of the southern part of the coastal plain in Texas, and he tentatively correlated them with the Uvalde. The gravels in Henderson and adjoining counties are lithologically quite similar to those in Leon County, but no attempt was made to trace them outside of the area studied. Since they contain no fossils and often occur at different levels, definite correlation would be difficult. It is possible that, instead of being Uvalde, they represent a high river terrace younger than Uvalde, possibly Asylum in age. The writers believe, but can make no definite stratigraphic proof, that the Trinity Terrace deposits are probably the upstream equivalents of the Lissie formation; that the Trinidad Terrace deposits may equal Beaumont; and that perhaps the Power Plant Terrace and the present flood plain deposits correlate with Recent deposits along the coast. Definite stratigraphic correlation must await downstream tracing of these deposits. On the basis of vertebrate fossils the writers tentatively assign the Trinity Terrace deposits to the interval of ice retreat following Wisconsin 2 or Tazwell stage of the Pleistocene epoch.

THE VERTEBRATE FOSSILS

The Pleistocene vertebrate fossils described in this paper were collected from sites on the Trinity Terrace (3) of the Trinity River in Henderson, Freestone and Navarro counties during 1939 to 1941 by Work Projects Administration projects 13129 and 13130. A bison skull from a site on the same terrace in Anderson County, donated by Mr. W. Q. Seale, Dallas, Texas, is also described. The majority of the material is fragmentary; however, included in the collections are 4 nearly complete skulls—the bison skull mentioned above, the skull of a horse, an elephant and a ground sloth. All of the material is well preserved. There follows a listing of the localities from which collections were made, together with a faunal list for each locality.*

Henderson County.—Fossil bones were collected from 5 different gravel pits, all of which are located in the vicinity of Trinidad.

Bishop gravel pit No. 1, Loc. Nos. 30760, and 30972; located 3.5 miles northeast of Trinidad, on the Judge Bishop farm.

Fauna: *Parelephas columbi, Equus complicatus, Tapirus* sp., and *Camelops* sp.

Bishop gravel pit No. 2, Loc. Nos. 30892 and 30893; located 3.5 miles northeast of Trinidad, west side of the Judge Bishop farm on Brushy Creek.

Fauna: *Equus complicatus, Megalonyx* sp.

Bishop gravel pit No. 3, Loc. No. 31011, located 100 yards due east of Bishop gravel pit No. 2.

Fauna: *Tapirus* sp.

Wharton gravel pit, Loc. Nos. 30731, 30787 and 30868; located ¼ mile

* The locality numbers used are catalogue numbers of the Bureau of Economic Geology at the University of Texas.

north of State Highway 31, on east side of the Trinity River, approximately 250 yards from the river.

Fauna: *Parelephas columbi, Equus complicatus,* Bison sp., *Camelops* sp., *Tanupolama* sp.

Leo Boatwright gravel pit, Loc. Nos. 30727 and 30907, (the majority of the fossils from this site are catalogued under No. 30907); located 2.5 miles northwest of Trinidad, on Leo Boatwright farm.

Fauna: *Mammut—Mastodon americanus, Parelephas columbi* (skull), *Equus complicatus* (skull), *Bison* sp., *Odocoileus* cf. *virginianus, Camelops* sp., *Tanupolama* sp., *Platygonus* sp., *Canis* sp., *Holmesina* sp., *Megalonyx brachycephalus* n. sp. (skull), *Didelphis* cf. *virginianus, Spilogale* sp., *Castor* sp., *Graptemys* sp., *Terrapene* sp., Bird, gen. indet.

Navarro County.—Valley Farms, Loc. No. 31030; located in northeastern part of county, 23 miles northeast of Corsicana, in levee cut.

Fauna: *Parelephas columbi, Equus complicatus, Bison* sp., *Odocoileus* cf. *virginianus, Camelops* sp., *Megalonyx* sp.

Freestone County.—John W. Carpenter farm, Loc. No. 31072; located 1.5 miles west of Trinity River, 100 yards south of State Highway 22.

Fauna: *Equus complicatus, Odocoileus* sp., Snake, indet.

Anderson County.—Loc. No. 31538; located in levee ditch adjacent to north side of Wildcat Ferry road, 4.7 miles west of Cayuga High School.

Fauna: *Mammut* (= *Mastodon*) *americanus, Parelephas* sp., *Bison occidentalis* (skull).

No fossils were collected from either the Trinidad or Power Plant Terraces; however, the writers have had reports of mastodon material obtained by local collectors from both the lower terraces and the present flood plain.

FAUNAL SUMMARY OF TRINITY TERRACE

Reptilia
- Testudinata
  - Emydidae
    - *Graptemys* sp.
    - *Terrapene* sp.

Aves—fam., gen. et sp. indet.

Mammalia
- Marsupialia
  - Didelphidae
    - *Didelphis* cf. *virginianus* Kerr
- Edentata
  - Megalonychidae
    - *Megalonyx** *brachycephalus* McAnulty n. sp.
    - *Megalonyx** sp.
  - Dasypodidae
    - *Holmesina** sp.
- Rodentia
  - Castoridae
    - *Castor* sp.
  - Rodent—fam., gen. et sp. indet.
- Carnivora
  - Canidae
    - *Canis* sp.

* Extinct. genera

Mustelidae
?Spilogale sp.

Proboscidea

Mastodontidae
*Mammut** (= *Mastodon*) *americanus* Kerr

Elephantidae
*Parelephas** *columbi* Falconer

Perissodactyla

Equidae
*Equus complicatus*** Leidy

Tapiridae
Tapirus sp.

Artiodactyla
Tagassuidae
*Platygonus** sp.

Cervidae
Odocoileus cf. *virginianus* Zimmerman

Camelidae
*Tanupolama** sp.
Camelops sp.

Bovidae
*Bison occidentalis*** Lucas

* Extinct genera.
** Extinct species.

DESCRIPTION OF THE BONES

Class REPTILIA—Family EMYIDAE

Graptemys sp.—One turtle specimen from the Boatwright pit, No. 30907-62,* consisting of the anterior 2/3 of the carapace joined to a complete plastron appears to belong to the genus *Graptemys*. The shell is marked with grooves and wrinkles along the sides, is moderately elevated, and shows a faint trace of the dorsal keel. The marginals are not suturally connected to the costals along the bridge. The neurals are hexagonal with the big end forward. The unguinal buttresses articulate with the 5th coastals. The plastron has a shallow lip in front and a well-developed posterior notch. There seems to be no great difference between this specimen and *Graptemys geographica*, a species at present inhabiting streams of the Mississippi valley. The greatest length of the plastron is 174.0 mm.; greatest width of the carapace is 153.0 mm.

Terrapene sp.—*Terrapene* is represented in the collection from the Boatwright pit by portions of 3 anterior lobes of the plastron, a portion of a posterior lobe, and numerous carapace fragments. The greatest length of anterior lobe No. 30907-19 is 83.8 mm.

Class AVES

Bird material consisting of 2 median phalanges, the distal end of a humerus, and the proximal end of a tibia-tarsus were collected from the Boatwright pit.

Class MAMMALIA

Order MARSUPIALIA—Family DIDELPHIDAE

Didelphis virginianus Kerr.—An opossum is represented in the collections by a left maxillary containing the C, F^3, and M^{1-4}. This specimen agrees in size and other characters with Recent specimens of *Didelphis virginianus*.

* All fossils bear the catalogue numbers of the Bureau of Economic Geology of the University of Texas.

Measurements in millimeters

Length: C—6.5, P3—5.5, M1—5.2, M2—6.0, M3—7.0, M4—5.0*, C-M4—44.4.
Width: C—4.0, P3—3.8, M1—4.4, M2—5.5, M3—6.9, M4—6.8.

Order EDENTATA—Family MEGALONYCHIDAE

Megalonyx brachycephalus n. sp.**

Holotype.—A nearly perfect skull, No. 30907-60, University of Texas, collections of the Bureau of Economic Geology.

Locality.—Leo Boatwright gravel pit, about 2.5 miles northeast of Trinidad, Henderson County, Texas.

Age.—Upper Pleistocene.

Specific characters.—Smaller than *M. jeffersonii, M. leidy, M. wheatleyi, M. milleri,* and *M. hogani.* Cranium extremely short, horizontal, and higher than the face. Frontal ridges strongly developed. Craniniform teeth set nearly parallel with midline of the palate.

Description of the Skull.—This is the most complete *Megalonyx* skull yet discovered. The caniniform and right cheek teeth, premaxillaries, presphenoid, and pterygoid processes are the only parts missing. Otherwise, it is perfectly preserved. The skull is considerably smaller than the skull for other species of the genus.

Along with the description that follows comparisons are made (i.e. where they can be made) with *M. jeffersonii* (Desmarest) (Leidy, 1855), *M. leidyi* Lindahl (1892), *M. wheatleyi* Cope (1899), *M. milleri* Lyon (1938), *M. hogani* Stovall (1940).

Superior View.—The short cranial region is horizontal along the midline from the supraoccipital crest to the frontal ridges and is elevated above the facial region. Between the strong frontal ridges anteriorly, the face is broadly depressed. The nasal region is concave, both transversely and anteroposteriorly. Divergence of the frontal ridges forms an angle of about 50 degrees. The supraoccipital crest is joined at right angles by a short sagittal crest, which is cut in a zig-zag line by the parietal suture. The frontals and parietals are pierced by numerous small foramens. From above, the surface of the parietals is slightly concave between the enlarged frontal ridges and the elevated rim of the supraoccipital crest.

Comparison with Megalonyx jeffersonii (Desmarest).—Leidy (1855) described 2 skulls of *M. jeffersonii* in his memoir on the Extinct Sloth Tribe. One he called the Owen specimen, the other the Dickeson specimen. The 2 skulls differ markedly in their dorsal aspect. The strongly convex nasal vault is higher than the cranium, the frontal ridges are weak, and the sagittal crest joins the supraoccipital crest at right angles in the Owen skull. In the Dickeson specimen the nasal region is much lower than the cranium, the frontal ridges are strong, and the sagittal crest slopes downward to join the supraoccipital crest.

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* on ectoloph.

** Named, but inadquately described, by the Junior author in "Megalonyx, Great Claw," *Texas Memorial Museum, Information Circular No. 16* (1940), pp. 1-6.

The sagittal crest is extremely short in *M. brachycephalus*, the length being 78.9 mm. as compared with 127.0 mm. for *M. jeffersonii*. In *M. jeffersonii* the length of the sagittal crest is 40.8 per cent of the distance from the supraoccipital crest to the anterior extremity of the nasals, while in *M. brachycephalus* that sagittal crest is only 24.6 per cent of the total length of the skull. *M. brachycephalus* is like the Owen specimen in that the sagittal crest joins the supraoccipital crest at right angles and quite unlike the Dickeson specimen in that respect. The parietal suture is a straight and open fissure in *M. jeffersonii;* in *M. brachycephalus* it is nearly closed and follows a zig-zag course along the crest. The frontal ridges are more strongly developed than in either of the skulls described by Leidy.

The height from the most prominent part of the face to the middle of the hard palate is 119.0 mm. in this specimen, 153.0 in the Owen specimen, and 146.0 mm in the Dickeson specimen. The width of the face at the postorbital protuberance is narrower than in the Owen specimen. The breadth of the cranium agrees closely with both specimens of *M. jeffersonii*. The face, from the first to the last molar alveolus, is relatively short; 140.0 mm. as compared with 178.0 mm. and 171.0 mm.; the length of the face from the postorbital protuberance is 104.0 mm. as compared with 119.0 mm. and 114.0 mm.

Comparison with Megalonyx leidyi Lindahl (1892).—In *M. leidyi* the superior border of the skull is nearly horizontal, while in this specimen the facial and nasal regions are considerably lower than the cranium. The sagittal crest slopes slightly downward to join the supraoccipital crest in *M. leidyi;* the two crests meet at right angles in this skull. In *M. leidyi* the sagittal crest is 46.6 per cent of the total length of the skull from the supraoccipital crest to the anterior extremity of the nasals, while in *M. brachycephalus* it is only 24.6 per cent of the total length. The length of the sagittal crest in Lindahl's specimen is 144.0 mm. as compared with 78.0 mm. for this specimen. The frontal ridges are more strongly developed, the facial region is more depressed, and the superior border of the nasals is more concave than in *M. leidyi*. The angle formed by the divergence of the frontal ridges is 76.5 degrees in *M. leidyi;* 50 degrees in this skull. The breadth of the skull at various points agrees closely everywhere except between the outer sides of the first cheek teeth alveoli, the measurment of which is 74.0 mm. in this specimen and 101.0 mm. for *M. leidyi*.

Comparison with Megalonyx milleri Lyon (1938).—The frontal ridges are stronger, the nasals more convex, and the face more depressed than in *M. milleri*. The angle of divergence of the frontal ridges agrees very closely in the 2 specimens; 50 degrees in *M. brachycephalus* and 46 in *M. milleri*. In both skulls the sagittal crest joins the supraoccipital crest at right angles; however, there is a considerable difference in the length of the sagittal crest, which is 95.0 mm. in *M. milleri* and 78.0 mm. in *M. brachycephalus*. In the species described by Lyon the sagittal crest is 33.8 per cent of the total length from the supraoccipital crest to the anterior end of the nasals; it is only 24.6 per cent of this length in *M. brachycephalus*. The temporal region is narrower and the sagittal crest is higher and sharper in *M. milleri* than in this skull. The breadth of the face at the outer side of the first cheek teeth alveoli is less in *M. brachy-*

cephalus; 74.0 mm. as compared with 109.0 mm. The length of the face and of the temporal fossae agree closely in the 2 specimens.

Comparison with Megalonyx hogani Stovall (1940).—Unlike *M. brachycephalus,* the superior border of the nasals is higher than the superior margin of the supraoccipital crest in Stovall's species. In the latter specimen the sagittal crest slopes downward from the frontal ridges to the supraoccipital crest. The frontal ridges are stronger and the face is more depressed in the area between the convex nasal cavity and the enlarged frontal ridges than in *M. hogani.* The angle of divergence of the frontal ridges is 50 degrees as compared with 84 degrees for *M. hogani.* The length of the sagittal crest is 95.0 mm. in Stovall's specimen; 78.0 mm. for this skull. The breadth of the skull is less at every point than in *M. hogani.*

Comparison with Megalonyx wheatleyi Cope (1899).—Cope assigned a great number of teeth, several lower jaw fragments, and 2 badly crushed skulls to *M. wheatleyi.* Since the best skull is crushed and lacks the muzzle, no comparison of any value can be made.

Posterior view.—The surface around the outer margin of the small occipital region is very rugose. The slope of the occiput makes an angle of 124 degrees with the plane of the sagittal crest. The supraoccipital crest forms a nearly perfect semicircle around a point on the midline on the upper border of the *foramen magnum* but is slightly flattened along the superior border. A high and narrow vertical crest, from the upper border of the *foramen magnum* to the supraoccipital crest, divides the occiput into 2 equal parts. On either side of this vertical crest, and just below the superior border of the supraoccipital crest, is a very weak transverse crest.

The paramastoid processes are directed backward and slightly inward. The *foramen magnum* is suboval in outline, the long diameter (33.0 mm.) being in the transverse direction. The distance between the inner borders of the occipital condyles is 48.0 mm.; the greatest width of an individual condyle is 34.0 mm. The occipital condyles project downward and backward and the articular surface is strongly convex, being bent just below the middle.

Comparison with Megalonyx jeffersonii.—The angle formed by the slope of the occiput with the plane of the sagittal crest in *M. brachycephalus* is 124 degrees and 104 degrees in *M. jeffersonii.* The supraoccipital crest is elevated medially along the superior margin in *M. jeffersonii,* while in this skull the crest is smooth and forms a nearly perfect semicircle. The occipital region is smaller and less rugose than that of *M. jeffersonii.* Both have a narrow vertical crest through the center of the occiput. The transverse crest just below the superior border is more prominent in *M. jeffersonii.* The *foramen magnum* is oval in this skull; circular in *M. jeffersonii.* The occipital condyles are alike in both species.

Comparison with Megalonyx leidyi.—The outline of the supraoccipital crest is decidedly polygonal in *M. leidyi,* the superior border bulging medially to form a broad tuberosity; in *M. brachycephalus* this crest is smooth and encloses the small occipital area in a nearly perfect semicircle. The distance

from the superior border of the *foramen magnum* to the superior margin of the supraoccipital crest is 70.0 mm. in this specimen and 107.0 mm. in *M. leidyi*. The breadth of the supraoccipital crest at the paramastoid processes is 141.0 mm. in this skull and 165.0 mm. in *M. leidyi*. The angle which the plane of the occiput makes with the plane of the sagittal crest is 124 degrees as compared with 108.5 for *M. leidyi*.

Comparison with Megalonyx milleri.—The two skulls differ markedly in the outline of the supraoccipital crest. This crest is irregularly elliptical with extensive lateral development where it joins the zygomatic arches in *M. milleri*, while in *M. brachycephalus* it is smooth and semicircular. Close agreement exists in the angle formed between the slope of the occiput and the plane of the sagittal crest. The height of the occiput is 70.0 mm. as compared with 97.0 mm. for *M. milleri;* the width at the paramastoid processes is 141.0 mm. as compared with 153.0 mm. for *M. milleri*. The palate is missing in *M. milleri*.

Comparison with Megalonyx hogani.—*M. hogani* is the only known species in which the angle between the occiput and the plane of the sagittal crest is less than a right angle (76 degrees). The 2 specimens differ also in the outline of the supraoccipital crest. In *M. hogani* it is elevated at the middle of the superior border and is heavier and wider around the entire border than that of *M. brachycephalus*.

Inferior View.—The basioccipital is concave between the condyles and then strongly convex for a short distance forward. Along this narrow convex region the sides slope into a deep backwardly directed fossa. These fossae are bordered anteriorly by enlarged protuberances, between which the basioccipital is concave. This concavity extends to about the union with the basisphenoid, at which point the surface flattens. The presphenoid and the pterygoid processes are missing.

On each side, near the inner border of the paramastoid process, is a prominent circular tuberosity on which there is an articular surface for the stylohyal. The exoccipital suture is visible along the inner and posterior borders of this tuberosity.

The stylomastoid foramen is located between this tuberosity and the paramastoid process; the large oval-shaped external auditory meatus is situated immediately anterior to this tuberosity. The large circular foramen ovale is directed outward and forward; the foramen retundum parallels the anteroposterior axis of the skull. The inferior borders of the occipital condyles are 105.0 mm. below the plane of the palate.

Anterior View.—The large nasal orifice is sub-oval in outline, the sides being flat and nearly vertical. The superior border is thin and broadly convex, except for a shallow concavity on each side leading backward to the anteorbital processes. All of the internal structure of the nasal region is obscured by a hard conglomeratic matrix.

Comparison with Megalonyx jeffersonii.—The nasal orifice is more circular, and the superior surface of the nasals is more convex than in *M. jeffersonii*.

The height at the anterior extremity is 98.0 mm. as compared with 127.0 for *M. jeffersonii*. The outward walls of the caniniform alveoli are more nearly vertical in *M. brachycephalus*.

The *Palate and Teeth*.—The alveoli for the caniniform teeth are directed more nearly parallel with the anteroposterior axis of the skull than in other species. Therefore, the palate is narrower at the posterior borders of these alveoli than in other specimens. It is also narrow and strongly convex between the cheek teeth, the width between the last cheek teeth being 29.0 mm. The first, second, and third cheek teeth are not placed obliquely to the midline of the palate, while the last tooth is set at right angles to the midline. The first cheek tooth is subterete in outline, the anteroposterior diameter on the inner side being slightly greater than the diameter on the outer side. The second and third cheek teeth are triangular, with the rounded apices on the outer side. The last tooth is ovate in outline with the apex on the inside. All of the cheek teeth have the sharp cutting edges typical of *Megalonyx*. The caniniform teeth are missing.

Comparison with Megalonyx jeffersonii.—The anteroposterior axis of the caniniform alveolus would make an angle of 15 degrees with the midline of the hard palate; in *M. jeffersonii* this angle would be 34 degrees. The angle at which these teeth are set effects the width of the hard palate at the posterior margins of the caniniform teeth. In this specimen this width is 68.0 mm., while in *M. jeffersonii* it is 102.0 mm. The width between the anterior margins of caniniform alveoli is 50.0 mm. in this skull and 61.0 mm. in the *M. jeffersonii*. The bulge on the inner side of the caniniform alveolus is smaller in this specimen.

The first cheek tooth is subterete in this specimen and triangular in *M.*

TABLE 1.—Comparative measurements of the cheek teeth.

	M. jeffersonii	*M. brachycephalus*
1st cheek tooth:		
Maximum length, internal	18.0 mm.	15.5 mm.
Maximum length, external	14.8 mm.	12.4 mm.
Maximum width	19.0 mm.	19.0 mm.
2nd cheek tooth:		
Maximum length, internal	20.0 mm.	16.0 mm.
Maximum length, external	12.7 mm.	11.0 mm.
Maximum width	25.4 mm.	23.0 mm.
3rd cheek tooth:		
Maximum length, internal	19.0 mm.	15.3 mm.
Maximum length, external	10.6 mm.	12.0 mm.
Maximum width	26.5 mm.	24.0 mm.
4th cheek tooth:		
Maximum length, internal	6.4 mm.	8.5 mm.
Maximum length, external	14.3 mm.	11.5 mm.
Maximum width	21.2 mm.	20.5 mm.

jeffersonii. The second is more triangular, and the third and fourth are less triangular, than the corresponding teeth of *M. jeffersonii*.

Comparison with Megalonyx leidyi.—A marked difference occurs in the angle at which the caniniform teeth set in reference to the midline of the hard palate; 54 degrees in *M. leidyi* and 15 degrees in *M. brachycephalus*. The width of the hard palate at the posterior margin of the caniniform alveoli is 68.0 mm. as compared with 96.0 mm. for *M. leidyi*. In the latter species the crowns of the first, second, and third cheek teeth are quadrate in outline, while in *M. brachycephalus* the first cheek tooth is quadrate but the second and third are triangular. The shape of the last cheek tooth is similar in both species.

Comparison with M. hogani.—The caniniform teeth are set at angles of 45 degrees to the midline of the palate in *M. hogani;* 15 degrees in this skull. The width of the palate at the posterior margins of the caniniform alveoli is 68.0 mm. in this specimen and 96.0 mm. in *M. hogani*. The shape of the first cheek teeth alveoli is similar in both skulls, but there are marked differences in the outlines of the alveoli for the remaining cheek teeth. The alveolus for the second cheek tooth in *M. brachycephalus* is triangular with the apex at the outer side, while in *M. hogani* it is subquadrate with bulges at the inner corners on both the anterior and posterior sides. The inner border of the third cheek tooth alveolus in *M. hogani* has a large bulge at the postero-inner corner, while in this skull the inner border of this tooth is straight and parallel with the midline of the palate. The fourth cheek tooth in this skull is compressed anteroposteriorly and more or less triangular in outline with the apex on the inner side. The tooth is quite different from that of *M. hogani* in which it has a subterete outline.

Comparison with Melagonyx wheatleyi.—The comparisons that can be made show that the teeth of *M. wheatleyi* are smaller than those of *M. brachycephalus*. According to Cope, the only character by which the superior molars of *M. wheatleyi* can be distinguished from those of *M. jeffersonii* is their smaller size. He points out that there is considerable variation in the shape of the superior molars. It is probable that the only character by which they may be distinguished from those of *M. brachycephalus* is their smaller size. However, the superior molars of *M. brachycephalus* appear to be proportionally wider than those of *M. wheatleyi*. In the latter species the bulge on the inner side of the caniniform tooth is large and near the anterior edge, while in this skull there is only a slight bulge located near the middle of the alveolus.

The Zygomatic Arches.—The zygomatic arches are complete in only one other specimen of this genus, the type of *M. leidyi*. In another specimen, *M. wheatleyi*, the arch of one side is nearly complete, lacking only the descending malar process.

As in *M. jeffersonii* and *M. leidyi*, the squamosal process of the zygomatic arch projects outward, downward and forward from the supraoccipital crest at an angle of about 45 degrees. The superior border of this process joins the supraoccipital crest at a point 52.0 mm. upward from the inferior margin of the paramastoid process. The upper edge is narrow, not more than 4.0 mm.

wide over the entire length. From the supraoccipital crest, the upper border of the squamosal process projects downward and forward in a convex line for a distance of 45.0 mm., thereby agreeing with *M. jeffersonii*, and differing from *M. leidyi*, in which the entire upper border is concave. The length of the squamosal process (measured along the superior border) from the supraoccipital crest to the union with the malar is 124.0 mm. The least vertical diameter is 33.0 mm.

The squamosal and malar processes are separated in this skull but are fused in *M. leidyi*. In the latter species the superior border of the squamosal process curves gently upward to join the posterior border of the dorsal prong at a sharp angle. Like *M. leidyi*, the external surface of the squamosal process is sigmoid. Above the glenoid fossa the external wall flattens and then turns outward to join the malar process. The inferior border has a much greater transverse width than the superior border and is slightly convex over the entire anteroposterior length. The glenoid fossa curves outward, downward and forward. The flat articular surface is elliptical in outline, the greatest length being 57.0 mm. and the greatest width being 27.0 mm.

The inferior border of the squamosal process meets the posterior border of the malar at an angle of 90 degrees, quite different from *M. leidyi* in which the inferior border of the squamosal process and the posterior border of the malar form a steady concave line. The bulge on the anterior border of the malar, directly in front of the suture between the malar and squamosal, is strongly convex in this specimen, more so than in *M. leidyi*. Below this bulge, the anterior edge drops backward and downward and then bends forward, forming the inferior and external borders of the orbit. As in *M. wheatleyi*, the squamosal process fits into a deep concave notch on the posterior border of the malar. Unlike *M. leidyi*, the malar process is elongated anteroposteriorly immediately below the inferior border of the squamosal process and downward for 25.0 mm.

The posterior root of the malar process is between the second and third cheek teeth, 15.0 mm. upward from the alveolar margin. The malar projects outward, downward and backward at an angle of 45 degrees. The anteroventral border forms a straight line for 114.0 mm., where it reaches the free portion of the ventral prong and suddenly turns backward and forms a convex line along the inferior border of the ventral prong. This process projects farther backward than in *M. leidyi*. The ventral prong, a thin and narrow process, 20.0 mm. wide and 5.0 mm. thick, is directed backward, downward and inward. A plane perpendicular to the anteroposterior axis of the skull, and tangent to the ventral prong, would pass anterior to the suture between the malar and squamosal process in *M. leidyi*, but in *M. brachycephalus* such a plane would cut the squamosal process at a point 45.0 mm. behind the suture. The apex is 98.0 mm. below the inferior border of the squamosal process. The ventral prong is shorter than that of *M. wheatleyi*, being 55.0 mm. as compared with 69.0 mm.

The dorsal prong of the malar projects upward, inward and backward. This process tapers rapidly toward the apex, the anteroposterior diameter being

27.0 mm. at the superior border of the squamosal process and 14.0 mm. near the apex. It projects backward at a greater angle in *M. leidyi* than in this skull. A plane tangent to the apex and perpendicular to the superior border of the squamosal process cuts the latter process at a point 43.0 mm. behind the malar-squamosal suture. This distance from the apex to the superior border of the squamosal process is 48.0 mm. The external surface of the dorsal prong is flat, and the anterior and posterior edges are thin, but it is strongly convex along the middle of the inner side. The length of the dorsal prong is greater than that of *M. wheatleyi*, being 57.0 mm. as compared with 39.0 mm.

Between the apices of the ventral and dorsal prongs the external surface of the malar process is broadly convex. The most lateral point from the side of the frontal is at the suture of the malar and squamosal process. The distance from the frontal to the inner side of the apex of the dorsal prong is 20.0 mm., at the suture, 55.0 mm. The distance from the apices of the 2 prongs is 172.0 mm. as compared with 184.0 mm. for *M. leidyi*. The entire span of the zygomatic arch is 217 mm. as compared with 257.0 mm. for *M. leidyi*.

Sutural Connections.—The complete obliteration of some and partial obliteration of most of the sutural connections indicates that the skull belonged to a mature individual. Sutures which are visible are also traceable in other specimens. The parietal suture along the sagittal crest is nearly closed, while in other species it is a gaping fissure. The supraoccipito-parietal suture is closed but is plainly visible as a straight line around the supraoccipital crest. The crenated squamosal suture can be traced throughout on the right side, but on the left side it becomes indistinct toward the middle of the temporal region. All connections between the frontals and adjoining elements are completely obliterated. The suture between the nasal and maxillary is visible on the left side, and the nasals are separated for a short distance at the anterior end. Sutures between the exoccipitals and supraoccipitals are not traceable, nor are they between any of the basilar elements of the skull. The zygomatic is separated from the malar process on both sides. All sutures around the lachrymals are obliterated.

Megalonyx sp.—A single tooth (No. 31071-5, second right upper cheek tooth) from the Crawford pit is quite similar to the corresponding tooth in the skull of *M. brachycephalus* from the Boatwright pit. It is smaller and less triangular than the same tooth of *M. jeffersonii*.

An anterior caudal vertebra, No. 31030-10, from the Valley Farms locality, belongs to *Megalonyx*. A phalanx, No. 30893-2, phalanx II, digit III or IV, collected from Bishop gravel pit No. 2, is also assigned to *Megalonyx*.

Family Dasypodidae, Holmesina sp.—A giant armadillo is represented in the collections by a portion of a right maxillary, a single carapace scute, and an anterior upper tooth.

Maxillary.—No. 30907-18, portion of right maxillary containing alveoli for five teeth. The inner alveolar walls are missing except for the anterior tooth. The anterior alveolus is small and oval in outline and is separated from the

TABLE 2.—Comparative skull measurements of *Megalonyx* (in mm.)

	M. brachycephalus	*M. jeffersoni* (Owen spec.)	*M. jeffersoni* (Dick spec.)	*M. leidyi*	*M. milleri*	*M. hogani*
Length of skull—occip. condy. to ant. margin 1st cheek teeth	256	356	33	343	291	245
Length from inion to ant. margin of nasals	276	311	—	309	281	—
Length of temporal fossa to postorb. protuberance	160	197	197	199	167	—
Depth of temporal fossa in straight line	95	102	114	108	93	—
Length of face from postorb. protuberance	104	119	112	115	101	—
Height of face from most prominent part to mid. hard pal.	118	153	146	136	—	—
Breadth of face at postorb. protuberance	120	127	138	123	129	142
Breadth of face at anterior extremity	83	95	95	83	98	108
Breadth of face at sides of first molar alveolus	74	114	114	101	ap 109	—
Height of face at anterior extremity	98	127	127	101	—	—
Diameter of orifice of nose	78	89	—	77	79	76
Length of face from first to last molar alveoli	140	178	171	150	—	—
Breadth of cranium at narrowest part of temporal rog.	86	90	102	91	75	98
Length of sagittal crest	78	127	127	144	95	95
Height of inion from foramen magnum	70	110	110	107	76	70
Breadth of inion at paramastoid process	141	159	165	165	153	175
Length of interval between first and second molars	41	50	—	40	—	—
Length of face from 1st to last molar alveoli	141	178	171	150	—	—
Length of maxilla from 2nd to 5th molar alveoli (inc.)	70	95	95	80	—	—
Antero-posterior width of caniniform alveolus	32	33	—	—	—	40
Transverse width of caniniform alveolus	20	21	—	—	—	25
Maximum width of 2nd cheek tooth alveolus	24	27	—	—	—	28
Maximum width of 3rd cheek tooth alveolus	23	27	—	—	—	31
Maximum width of 4th cheek tooth alveolus	20	17	—	—	—	15

next alveolus by a short diastema (5.0 mm.). All of the alveoli except the first contained bi-lobed teeth. The anterior alveolus probably contained the fourth tooth; and, if this is true, the following alveoli contained the fifth, sixth, seventh, and eighth teeth. Many small pits are scattered over the outside of the bone along the alveolar margin. The maxillary is swollen outward over the alveolar margin.

Measurements (in millimeters)

	Length	Width	Depth
1st alveolus (for ? 4th tooth)	7.0	5.0	15.0
2nd alveolus for ? 5th tooth)	19.00	—	16.00
3rd alveolus (for ? 6th tooth)	21.0	—	21.5
4th alveolus (for ? 7th tooth)	17.0	—	19.0
5th alveolus (for ? 8th tooth)	15.0	—	11.5

Scute.—No. 30907-35. This bone is small, flat, and hexagonal in outline. The thickness is 9.0 mm., and the greatest diameter is 35.0 mm. On the external surface, about 3.0 mm. inside the margins, is a ridge which parallels the outer margins and encloses a depressed area in the center. The central depression is cut by a straight diagonal ridge. Between the outer edges and the marginal ridge are numerous small pits. The inner surface is smooth and slightly concave.

Tooth.—An anterior upper tooth, No. 31070, from the Crawford pit, belongs to *Holmesina*. The tooth is sub-oval in outline, the anteroposterior diameter being the greatest. The outside is convex, while the inside is slightly flattened and marked by a shallow vertical groove. The anterior edge is slightly convex and the posterior edge is slightly concave. The occlusal surface is flat and smooth.

Measurements

Anteroposterior diameter	13.0 mm.
Transverse diameter	18.0 mm.
Height	33.5 mm.

Order RODENTIA

Family Castoridae, Castor sp.—Three beaver teeth were collected from the Boatwright pit; a portion of an incisor, No. 31907-18A, and 2 upper molars, Nos. 30907-16B and 30786-2. The molars, which appear to be M^2 and M^3, have the typical *Castor* pattern.

Measurements

Width of enamel on incisor		7.6 mm.
M^2 :	length of crown	7.5 mm.
	width of crown	8.0 mm.
M^3 :	length of crown	6.3 mm.
	width of crown	7.6 mm.

Rodent.—Two incisor teeth, No. 30907-82, of a small rodent from the Boatwright pit are unidentifiable. The width of the enamel on one tooth is 2.0 mm.; on the other, 2.5 mm.

Order CARNIVORA

Family Canidae, Canis sp.—Coyote is represented in the collections by the following fragmentary remains: a portion of lower left jaw containing P_4-M_2, No. 30907-14; a canine tooth, No. 30907-71; the distal end of a femur, No. 30907-59; and a proximal phalanx, No. 31070-9.

Lower jaw.—The anterior slope of P_4 is relatively low and long. There is a distinct "step" cusp and a well-developed tubercle on the cingulum at the posterior border. The metaconid and entoconid are subequal and opposite and the hypoconid is slightly stronger. The protoconid of M_2 is relatively large and is connected with the anterior cingulum by a weak ridge. The metaconid is smaller than the protoconid and is situated slightly behind it. The hypoconid forms a strong outer ridge and the entoconid forms a weak inner ridge. A small alveolus for M_3 is present. The masseteric fossa is deep and extends forward below the heel of M_2. The coronoid process is relatively low.

Measurements (in millimeters)

	Fossil No. 30907-14	Recent Jaw Canis nebrascensis
P_4 : length	13.1	13.3
: width	6.0	5.6
M_1 : length	22.2	21.5
: width	8.5	8.2
M_2 : length	10.0	9.5
: width	7.3	6.7
Length—M_1-M_3	37.6	36.4
Depth of jaw below M_1	20.5	19.0
Height coronoid process	51.7	55.7

Family Mustelidae, ? Spilogale sp.—Portions of two lower jaws, No. 30907-83, from the Boatwright pit, appear to belong to a small skunk. Neither of the rami have teeth, but their size and the shape and number of alveoli agree with a Recent specimen of *Spilogale*.

Order PROBOSCIDEA

Family Mastodontidae, Mammut (= *Mastodon*) *americanus* Kerr.—One tooth and enamel fragments of another tooth are the only remains of mastodon collected in this area. The tooth, No. 31070-6, a lower second molar, is from the Crawford pit. The fragments of the other tooth were collected from the Boatwright pit. Mastodon remains collected from Locality No. 31538, near Cayuga, Anderson County, are said to be on display in the Cayuga High School. The Bureau of Economic Geology has only a bison skull from this locality.

Family Elephantidae, Parelephas columbi (Falconer.)—Relatively few elephant remains are present in the collections from this area. However, a nearly perfect skull of *Parelephas columbi* was obtained from the Boatwright pit. Other material consists of four milk teeth and portions of two lower molars, a complete humerus, and a few other complete and fragmentary skeletal elements.

Skull.—No. 30907-61, on exhibition in the Texas Memorial Museum. This specimen is well preserved and complete except for the nasal process, left jugal, posterior process of right jugal, and a portion of the distal extremity of the left tusk sheath. It is a medium-sized skull. The facial region has very little curvature in the longitudinal direction. The tusk sheaths bend downward slightly from the external nasal opening. There are 2 teeth present on each side, the anterior pair being fragments ready to be shed. There are 12 plates on the grinding surface of the functional molars. A 100 mm. line crosses 6 of these ridge plates. Because of the excellent condition of this skull it seems appropriate to give its measurements in considerable detail. See Table 3.

Milk molars.—No. 31070-11; 1st milk tooth, lower. The grinding surface is well worn and reveals 5 plates, the enamel ridges of which form a simple pattern. The sides of the crown are covered with a relatively heavy coating of cement. There are 2 well-developed roots, of which the posterior is the stronger, and also a very weak median root.

Measurements

Length of crown	25.0 mm.
Width of crown	18.3 mm.
Height of crown	10.5 mm.
Length of posterior root	26.0 mm.

No. 30907-79; 2nd milk tooth, lower. This tooth shows considerable wear, the grinding surface extending over the entire length of the crown. There are 6 plates plus anterior and posterior talons. The enamel ridges of the plates are somewhat crenated and bend in and out across the tooth. The anterior root is broken away at the base of the crown. The portion of the posterior root which is present indicates that the posterior root was well developed.

Measurements

Length of crown	79.5 mm.
Width of crown at plate 1	24.3 mm.
Width of crown at plate 5	35.6 mm.
Height of crown at posterior end	42.0 mm.
Height of crown at anterior end	16.0 mm.

No. 31030-3B. 2nd milk tooth, lower. This tooth never came into wear. No cement is preserved and the roots are broken away at the base of the crown. There are 7 plates, plus anterior and posterior talens. Plates 2, 3, and 4 stand perpendicular to the base and are separated from each other and from anterior and posterior plates. Plate 1 leans forward from the base and

closely appressed to it is a rather strong anterior talon. Plate 5 leans forward only slightly. Plate 6 leans forward near the top and fits against plate 5. Plate 7 is recurved over its entire length and is separated from plate 6. The posterior talon originates upward from the base on the posterior side of plate 7 and is closely appressed to that plate.

TABLE 3.—Measurements of skull of *Parelephas columbi*. No. 30907-61 (in millimeters).

Distance from upper border of foramen magnum to top of occipital crest	420.0
Greatest width of occipital region	670.0
Distance between external auditory mantus	590.0
Transverse diameter of foramen magnum	100.0
Vertical diameter of foramen magnum	59.0
Distance between outer borders of occipital condyles	224.0
Vertical diameter of occipital condyle	90.0
Length of basioccipital	176.0
Width of palate between last molars (post. end)	55.0
Distance from auditory meatus to anteorb. process	435.0
Distance from aud. meatus to suture between squamosal and jugal (on upper edge of arch)	170.0
Length of jugal	325.0
Length of zygomatic process of maxillary	128.0
Vertical diameter at suture between jugal and maxillary process of the zygomatic arch	170.0
Least vert. diam. of jugalar process of zy. arch	75.0
Least trans. diam. of jugal in middle of zy. arch	49.0
Trans. diam. of condyle for lower jaw articulation	106.0
Distance between postorb. and anteorb. processes	146.0
Greatest diameter of infraorbital foramen	59.0
Distance from occipital crest (vertex) to lower extremity of premaxillaries	1140.0
Distance from lower border of nasal opening to lower extremity of premaxillaries	560.0
Width of premax. (tusk sheath) across lower end	455.0
Least transverse diameter of tusk sheath, measured 270 mm. below the lower border of nasal opening	350.0
Distance from anterior end of palate to lower extremity of premax. along midline suture	387.0
Transverse diameter of tusk alveolus	130.0
Vertical diameter of tusk alveolus	105.0
Least transverse diameter between orbits	480.0
Transverse diameter between postorbital processes	630.0
Greatest transverse diameter of nasal opening	115.0
Length of grinding surface of teeth	205.0
Width of grinding surface of teeth	101.0

Measurements

Length of crown	72.3 mm.
Greatest width of crown at plate 7	35.4 mm.
Greatest width of crown at plate 1	20.2 mm.
Height of crown at plate 1	34.0 mm.
Height of crown at plate 7	44.8 mm.

No. 31030-3A. 2nd milk tooth, upper. None of the roots are complete, but the portions present indicate that there were 3 well-developed roots, the middle root being the weakest of the 3. There are 7 plates and a posterior talon. Only the first four plates show wear. The worn surface of this tooth cuts the plates at an angle of about 45 degrees, while in all the lower milk teeth described above the worn grinding surface cuts the plates approximately at right angles.

Measurements

Length of crown	63.5 mm.
Greatest width of crown (at 6th plate)	41.0 mm.
Width of crown at plate 1	28.0 mm.
Greatest height of crown (at 6th plate)	52.5 mm.
Height of crown at plate 1	25.7 mm.

Order PERISSODACTYLA

Family Equidae, Equus complicatus Leidy.—Horse is better represented in the collections than any other form; remains are present from every site except Bishop gravel pit No. 3, Locality No. 31011. Included is a partial skull, and several skeletal elements.

The skull lacks the following of being complete: anterior margin of the premaxillae; left zygomatic arch, posterior wall of orbit and glenoid fossa; the nasals; portion of right parietal; and the paramastoid processes. Both specimens are from old adult animals. The folding of the enamel around the lakes on the teeth is relatively complex, being more complex on the molars than on the premolars. The enamel on all the teeth is crenulated. The protocones on the teeth of these specimens are less elongate than those of most of the isolated teeth in the collections. The styles of the premolars are relatively slender; the mesostyles are minutely bifid. In general, the size and proportions of the skull and teeth and the pattern of the enamel agree with *Equus complicatus*. See Table 4 for measurements.

Family Tapiridae, Tapirus sp.—A loph of a cheek tooth and an upper second incisor are the only tapir remains in the collections from the Trinity River terrace sites. No. 30972-5, an unworn loph of a cheek tooth, from Bishop gravel pit No. 1; No. 31011-2, I^2, from Bishop gravel pit No. 2. The incisor is appreciably larger than the corresponding tooth of *Tapirus terrestris*, No. 16, of the Recent skeletal collections of the University of Texas, Bureau of Economic Geology.

Order ARTIODACTYLA

Family Tagassuidae, Platygonus sp.—Peccary is represented in the collections by 4 complete teeth and 2 tooth fragments, all from the Boatwright pit.

TABLE 4.—Measurements of Equus skull and palate (in millimeters)

	Skull, No. 30907-52	Palate, No. 30907-41
Distance from front of premax. to front of foramen magnum	544.0 ap.	—
Distance from front of premax. to rear of glenoid fossa	484.0 ap.	—
Distance from front of premax. to front of posterior nares	288.0	—
Distance from front of premax. to front of PM2	144.0	—
Width across glenoid fossa	200.0 ap.	—
Width from outside to outside of last molars (M3)	125.0	125.0
Diameter of orbit, fore and aft	69.5	—
Width of palate at last molars (M3)	71.0	75.0
Width between outer side of mesostyles Pm2	102.0	112.0
Least width of space between I3 and Pm2	53.0	—
Distance between I3 and Pm2	117.0	—
Length of premolar series (right side)	109.0	99.5
Length of molar series (right side)	83.0	84.6

These teeth belong to the genus *Platygonus* but are not specifically determinate. There is a lower premolar, 2 lower molars, and 1 upper tooth (?P3). In the lower teeth, both the premolar and molars have well-developed anterior and posterior cingula; the premolar has a slight posterior "heel" with a low cusp extending inward from the middle of the cingulum. The anterior loph of the premolar is high and notched in the center. Except for one which is worn, the molars are likewise high crowned. The upper tooth is worn to its base but appears to have had 2 external cusps and 1 large internal cusp, with a prominent central depression. It possesses anterior and posterior cingula.

Measurements (in millimeters)

	Width	Length	Height
No. 30907-37A, Pm	12.0	9.7	13.2
No. 30907-37B, ?M	19.1	13.3	12.4
No. 30907-37C, M	15.2	10.6	7.7
No. 30907-22, ?P3	13.0	12.8	8.7

Family Cervidae, Odocoileus virginianus Zimmerman.—A few fragmentary remains of white-tailed deer are present in the collections, including parts of 7 lower jaws; 3 odd teeth; 5 horn-core burrs; the centrum of an axis; 1 complete metatarsal and parts of 3 other metapodials; a portion of a scapula; and 2 estragalae.

Lower jaws.—No. 30907-17A, posterior portion of right ramus containing M_2-M_3, teeth slightly worn. The crescents are arranged obliquely and the styles are rather prominent. M_2 has a small ectostylid; M_3 has a small tubercle-like pillar at the base on the outer side between the first two columns.

No. 30907-17C, median portion of right ramus containing DP_{2-4}, M_{1-2}, deciduous premolars sightly worn; M_2 unworn. DP_3 has a large anterior lobe and 3 postero-internal ridges. DP_4 has strong external pillars; M_1 has a relatively strong external pillar.

No. 30907-19A, jaw fragment containing P_{3-4}, teeth badly worn.

No. 30907-47, portion of right ramus, containing P_{3-4}, adult, teeth slightly worn. P_4 has a strong antero-internal lobe. Each molar has a strong external pillar.

No. 30907-38, portion of right and left rami, same individual, teeth badly worn.

No. 30907-67, posterior portion of left ramus, containing M_{2-3}, teeth slightly worn.

Horn cores.—All of the horn-core bases have distinct burrs and appear referable to *Odocoileus*.

Metatarsal.—No. 30907-11, a complete metatarsal. This bone is not appreciably different from the corresponding elements of a Recent skeleton from central Texas. The groove for the extensor tendon is closed over for 14.0 mm. from the base.

Measurements

Length	211.0 mm.
Width at distal end	24.5 mm.

Family Camelidae, Tanupolama sp.—One lower second molar, two metapodial fragments and one phalanx appear to be referable to the Pleistocene llama, *Tanupolama*. These remains are smaller and more slender than the corresponding elements of *Camelops*. M_2 closely resembles that of *Tanupolama stevensi*, as described and figured by Stock (1928).

Measurements

M2:

Greatest anteroposterior diameter	24.0 mm.
Greatest transverse diameter	16.0 mm.

Camelops sp.—Material in the collections referable to this genus of camels includes a maxillary fragment containing two broken and worn molars, a portion of a lower jaw containing part of a lower molar, a complete third lower molar, and one immature metacarpal. M_3, the only complete tooth, has a

well-developed posterior (third) lobe, the inner wall of which is nearly on the same plane with that of the anterior lobes. The inner ribs are weak and there is no antero-internal buttress.

Measurements

M3:

Greatest anteroposterior diameter	56.0 mm.
Greatest transverse diameter	19.8 mm.
Greatest height	56.0 mm.

Metacarpal:

Length	340.0 mm.
Width at distal end	64.5 mm.
Width at proximal end	61.7 mm.

TABLE 5.—Measurements of lower teeth of *Odocoileus* (in millimeters).

	30907-17A Rt. Ramus	30907-17C Rt. Ramus	30907-3E Jaw frag.	30907-38 Rt. Ramus	30907-38 Lt. Ramus	30907-47 Rt. Ramus	30907-67 Lt. Ramus	Rec. spec. from C. Tex.
DP2, length	—	broken	—	—	—	—	—	—
DP2, width	—	3.0	—	—	—	—	—	—
DP3, length	—	11.2	—	—	—	—	—	—
DP3, width	—	5.5	—	—	—	—	—	—
DP4, length	—	17.7	—	—	—	—	—	—
DP4, width	—	8.0	—	—	—	—	—	—
Length DP2-DP4	—	35.0	—	—	—	—	—	—
P2, length	—	—	—	—	—	—	—	8.0
P2, width	—	—	—	—	—	—	—	5.0
P2, height	—	—	—	—	—	—	—	5.0
P3, length	—	—	9.8	9.5	—	10.8	—	11.3
P3, width	—	—	6.0	5.5	—	6.0	—	6.9
P3, height	—	—	4.3	worn	—	6.4	—	5.5
P4, length	—	—	11.2	—	—	11.8	—	12.6
P4, width	—	—	7.8	—	—	7.2	—	8.3
P4, height	—	—	4.8	—	—	7.5	—	6.0
P4, length	—	14.5	—	—	11.3	12.5	—	12.3
M1, width	—	8.4	—	—	8.3	8.2	—	10.3
M1, height	—	—	—	—	worn	5.0	—	4.7 worn
M2, length	15.2	—	—	broken	13.8	15.5	14.9	16.5
M2, width	9.8	—	—	—	9.5	9.9	10.2	10.0
M2, height	11.9	—	—	—	worn	8.0	9.8	5.8
M3, length	18.6	—	—	—	—	—	18.8	20.0
M3, width	9.0	—	—	—	—	—	9.8	9.8
M3, height	11.5	—	—	—	—	—	9.9	9.0
Depth of ramus below	broken	—	—	19.2	broken	23.5	21.8	20.0

Length.—Measured at crown on inside of tooth. Width.—Measured at base of enamel. Height—From base of enamel to highest point in crown, measured on inside of tooth.

Family Bovidae, Bison occidentalis Lucas.—Bison is represented in the collections by a nearly complete skull, several isolated teeth, and a few miscellaneous skeletal parts. The skull, No. 31539-1, from near Cayuga, Anderson County, is well-preserved and complete except for the following: anterior portion of the premaxillae, anterior portion of the nasals, tip of right horn-core, left orbit and posterior wall of right orbit, both zygomatic arches, the pterygoid processes, P^{2-3} of left side, and P^3 of right side. This skull is considerably larger than that of any living species. It probably represents an old male. The horn-cores are quite robust and strongly curved. The bases of the horn-cores are very rugose and considerably larger than that portion between the bases and the forehead. The axis of each horn-core makes an angle of approximately 100 degrees with the longitudinal axis of the skull. The tips point inward and backward. The index of curvature, i. e., the length of the horn-core along the lower curve, divided by the distance from the base on the upper side to the tip (measured in a straight line), multiplied by 100, is 175.

The forehead is broadly convex and relatively wide between the horn-cores. Just above the occipital crest, the occipital bone bends over the crest and forms a flattened semicircular ares, bounded anteriorly by the frontals, with a maximum transverse diameter of 180.0 mm. and a maximum anteroposterior diameter of 74.0 mm. The plane of this portion of the occipital forms an angle of approximately 110 degrees with the plane of the facial region. The orbits are very prominent and the area between them is somewhat flattened. That part of the face in front of the orbits is relatively narrow, and strongly convex over the superior margin. The palate is relatively narrow. Except for size, the teeth exhibit no diagnostic difference from those of Recent species. This statement is also true for the various skeletal elements.

Age and Relations of the Fauna.—Although fragmentary, evidence of the life of the glacial and interglacial ages is widespread. As a result, volumes

Measurements of teeth in skull No. 31538-1 (in millimeters)*

P3	
Length	21.0
Width	23.0
P4	
Length	21.0 ap.
Width	broken
M1	
Length	27.3
Width	32.5
M2	
Length	35.3
Width	30.0
M3	
Length	38.0
Width	30.5
Length of molar series	104.0

* For comparative skull measurements see Table 6.

TABLE 6.—Comparative measurements of skulls of *Bison occidentalis* (in millimeters).

	Texas spec. No. 31538-1	*Type spec.	*Am. M. N. H. No. 13721	*U. S. N. M. No. 5514	*U. S. N. M. No. 2643	*Spec. at Univ. Kansas
Length from middle of occipital crest to rear of nasals	287	266	285	280	260	271
Distance from upper lip of foramen mag. to middle of occip. crest	105	107	110	102	102	—
Distance between bases of horn cores	370	297	335	320	312	370
Distance between lower border of foramen mag. to rear of nasals	267	280	—	270	—	—
Width of skull at auditory openings	275	273	280	290	298	305
Width of skull at hinder end of temporal fossae	175	175	200	187	202	195
Width of skull at constriction between orbits and bases of h. cores	306	297	295	298	300	360
Width of skulls at rear of orbits	356	355	355	368	—	397
Width of palate between anterior premolars	72	—	90	—	—	—
Width of palate between hinder molars	91	—	132	—	—	—
Diameter of orbit	82	—	72	—	—	—
Diameter of base of horn cores, fore and aft	107	102	118	105	115	107
Diameter of base of horn cores, vertical	94	96	95	88	95	92
Circumference of horn cores, at base	340	300	320	310	336	325
Length of horn core, on upper curve	425	298	355	330	325	310
Length of horn core, on lower curve	510	365	420	415	415	375
Distance between tips of horn cores	788	700	920	810	808	880
Dist. from middle of occip. crest to rear of orbit—straight line	236	290	288	295	—	—

* Measurements after Hay (1913).

have been written on Pleistocene life. But fixing of the stratigraphic range of the animals and plants has so far proved to be difficult and uncertain. Most of the works, such as Hay's (1923, 1924, 1927) 3 large volumes, which purport to give the precise time-distribution of Pleistocene species, have proved to be thoroughly unreliable. Many workers feel that much remains to be done before the age of a Pleistocene deposit can be zoned as to a particular glacial or interglacial stage on the basis of its fossils; some believe that the epoch was too short, geologically, for conspicuous evolution to have occurred and that subdivision can never be made on the basis of fossils. The writers believe that the Pleistocene can be zoned as to glacial and interglacial faunas and that it will be done in the future by careful, detailed work.

Dr. George G. Simpson (1947), Curator of Fossil Mammals and Birds at the American Museum of Natural History, states in regard to the problem:

> really close dating will involve discrimination of successive subspecies or even lesser mutational steps, which, for any reliability, will demand large samples treated by refined statistical methods—work of a sort that does not yet exist. The present status is that we need to accumulate many more samples that can be put in correct sequence on stratigraphic data—we are still in the stage of dating the fossils from the beds, rather than the beds from the fossils, when it comes to minor subdivisions of the Pleistocene.

Dr. Claude W. Hibbard (1947), Associate Curator of Vertebrates, Museum of Paleontology, University of Michigan, says:

> do not let anyone tell you, you cannot zone the Pleistocene as to glacial and interglacial faunas. It can be done and will be done in the future. . . . We need more rodents, rabbits and insectivores from deposits yielding the larger forms, and we also need more large forms from horizons yielding small forms.

The Trinity Terrace fauna certainly does not provide one with all the data needed for close, specific dating, but it is suggestive. It contains 17 identifiable genera, many of which probably ranged throughout the Pleistocene. Six of the genera are not extinct. Only 6 species were identified, 4 of which are extinct. As nearly as can be determined the range of the genera and species listed is as follows:

Genera and species	Range
Graptemys and *Terrapene*	Unknown; probably Pleistocene to Recent
Didelphis virginianus	Pleistocene to Recent; this is the 2nd Pleistocene record
Megalonyx brachycephalus	n. sp., unknown; *Megalonyx* from Pliocene to late Pleistocene
Holmesina	?Middle to late Pleistocene
Castor	Pleistocene to Recent
Canis	Upper Pliocene-Recent
Mammut (= *Mastodon*) *americanus*	Early Pleistocene to post Wisconsin
Parelephas columbi	Middle Pleistocene to ?post Wisconsin
Equus complicatus	?Middle Pleistocene to late Pleistocene
Tapirus	?Pliocene to Recent
Platygonus	Upper Pliocene to post Wisconsin
Odocoileus virginianus	Late Pleistocene to Recent
Tanupolama	Upper Pliocene to late Pleistocene
Camelops	Upper Pliocene to late Pleistocene
Bison occidentalis	Late Pleistocene

Every genus and species listed above is known to occur in late Pleistocene deposits, while *Odocoileus virginianus* and *Bison occidentalis* are probably confined to that age. Thus the age of the fauna is late Pleistocene.

The faunal summary, but no stratigraphic data, was sent to several outstanding vertebrate paleontologists, and these questions were asked of them:

> In your opinion, does the assemblage, as a whole, characterize any certain division of the Pleistocene? If not, are any of the genera or species present characteristic of, or restricted to, any certain part of the Pleistocene?

There follows excerpts from their replies.

Dr. Chester Stock (1947), Professor of Vertebrate Paleontology, California Institute of Technology:

> I wish I might be helpful in closer age identification of Pleistocene faunas. This is, however, a difficult problem and one that cannot be definitely answered until the picture is clearer concerning the succession of mammalian types during Pleistocene time. . . . I think that McKittrick is quite late but am unable to do any closer dating than that at the present time.

Dr. George G. Simpson (1947), Curator of Fossil Mammals and Birds, American Museum of Natural History:

> As regards the grosser subdivisions, your list is suggestive . . . it seems reasonably certain that this is not an early Pleistocene assemblage and more likely that it in later than middle Pleistocene. All of the listed genera and species (except of course your new species) have been recorded from deposits that a consensus would place, on other evidence, in the very latest Pleistocene or even the earliest Recent. Unfortunately, however, most of them have also been found in deposits claimed to be considerably older. In the present state of knowledge, the most significant single species on your list is *Bison occidentalis*. There is an increasing amount of evidence that this species, and its probable synonyms or close allies among the extinct relatively small-horned bison, did not appear in North America until near the end of the Pleistocene.

Dr. Paul O. McGrew (1947), Professor of Vertebrate Paleontology, University of Wyoming:

> Every genus and species you list occurs in known late Pleistocene deposits and the one, *Bison occidentalis*, is probably confined to that age. . . . I would not hesitate to call the fauna late Pleistocene and would suggest the Wisconsin glacial period as the best possibility.

Dr. Claude W. Hibbard (1947), Associate Curator of Vertebrates, Museum of Paleontology, University of Michigan:

> First I must assume that all vertebrates listed by you are correctly identified and taken from the same horizon, also, that the sands and gravels were laid down at the same time. Second that no older Pleistocene fossils were reworked into the deposits and furthermore that none of the forms are surface intrusion. Assuming these facts the fauna is late Pleistocene. . . . If your collection is not mixed I would definitely say post Illinoian. The fauna is related to Cragin Quarry-Jones Ranch.

Dr. R. A. Stirton (1947), Professor of Vertebrate Paleontology, University of California:

> The presence of Bison indicates that your fauna belongs in the later part, perhaps upper half of the Pleistocene.

Three stone images carved to represent a man's head, were found in the Bishop pits. These have been described by Sellards (1941).

During the period that the junior author was state supervisor of the paleontologic-mineralogic survey in Texas, a large fauna was obtained from an old pond fill in coastal deposits near Ingleside, San Patricio County, Texas, and a fairly extensive fauna was collected from a terrace of the Mission River drainage system in Bee, Goliad and Refugio counties. The junior author is familiar with the fossils from both localities in that he supervised the preparation of them.

Sellards and Evans (1940) traced the Mission River Terrace, named Berclair Terrace, coastward and concluded that it was equivalent with Lower or Middle Beaumont. Sellards compared the Berclair fauna with faunas from Ingleside, Texas and Vero, Florida and suggested that all 3 are equivalent in age. The stratigraphic position of the Ingleside deposit indicates Middle Beaumont. The Ingleside fauna is much more extensive than the Trinity Terrace fauna, including all the genera present in the latter except *Graptemys, Terrapene, Didelphis* and *Spilogale*. The following genera present in the Ingleside assemblage are not represented in the collections from Trinity Terrace: *Cervus, Capromeryx,* antilocaprid indet, *Aenocyon, Smilodon, Felis, Ursus, Cynomys, Lepus, Geomys, Reithrodontomys, Mylodon, Nothrotherium, Dasypus, Boreostracon, Testudo, Cistudo, Trionyx, Amphisbaena, Alligator, Lepisosteus,* and *Amiurus.*

Perhaps the absence of these genera from the Trinity Terrace can be explained as being due to different environmental conditions. It may be that the Ingleside fauna is glacial and Trinity Terrace is interglacial. Of the genera listed above, *Nothrotherium* is probably the most significant. It is usually associated with very late Pleistocene deposits and is known to occur in the early Recent. The writers are of the opinion that the Trinity Terrace fauna is slightly older than either the Berclair or Ingleside faunas; certainly it is not younger.

The Ingleside fauna is quite similar to that of Rancho La Brea. According to Stock (1947), the Trinity Terrace assemblage is similar to that of McKittrick. But California geologists have not been able to agree as to where Rancho La Brea and McKittrick should be placed in the Pleistocene. Hibbard (1947) believes that the Trinity Terrace fauna is related to Cragin Quarry--Jones Ranch, which is considered late Wisconsin in age.

CORRELATION OF THE TERRACES WITH THE GLACIAL DEPOSITS

Assuming that the writers' theory as to the origin of the Trinity River terrace is correct, the following outline of the geologic history, in reverse order, can be adduced:

I. Decrease in stream gradient (rise in sea-level—recession of present ice caps) and deposition of approximately 30 feet of alluvium in the stream valley —present flood plain. Stream aggrading at present.

II. Erosion of stream valley down through about 35 feet of alluvial fill (Power Plant Terrace left as an erosional remnant), and 15 feet into bed rock. (Rejuvenation probably the result of uplift of the land and a lowering of sea level during growth of present ice caps.)

III. Alluviation of the stream valley to a depth of at least 35 feet—materials composing Power Plant Terrace. (Probably aggraded as a result of a rise in sea level brought about by a recession of the ice.)

IV. Stream rejuvenated and cut down through about 30 feet of its own valley fill (Trinidad Terrace left as an erosional remnant) and 10 feet into the underlying bed rock. (Started degrading probably as the result of a lowering of sea level caused by glacial growth; possibly also by coastward tilting.)

V. A period of alluviation of the stream valley, 30 feet of fill—materials composing Trinidad Terrace. (Rise of sea level during recession of the ice.)

VI. A period of degradation, stream cut downward through at least 50 feet of alluvial fill (Trinity Terrace left as an erosional remnant) and another 10 feet into bed rock. (Rejuvenation of stream probably caused by coastward tilting of coastal plain and a lowering of sea level resulting from glacial growth.)

VII. Long period of aggradation of a wide stream valley—55 feet or more of gravels, sands, silts, and clays laid down by the stream—materials composing Trinity Terrace. A few skeletal remains of some of the land animals living in the area at that time were entombed and preserved in the sediments—Trinity fauna. (Stream deposited in its valley probably as a result of a rise of sea level during a time of ice retreat.)

Assuming that existing ice caps represent a distinct waxing of an ice sheet since the latest Wisconsin ice retreat, the steps outlined match up with the glacial scale in this manner:

Step No. I. ....Recession of existing ice caps.
Step No. II. ....Growth of present ice caps.
Step No. III. ....Recession of Mankato ice.
Step No. IV. ....Growth and advance of Mankato ice.
Step No. V. ....Cary-Mankato interval.
Step No. VI. ....Growth and advance of Cary ice.
Step No. VII. ....Tazwell-Cary interval

The above correlation would give the following scale:

Formation	Geologic Time
Present flood plain	Late Recent
Power Plant Terrace	Early Recent (Mankato ice retreat)
Trinidad Terrace	Cary-Mankato interval
Trinity Terrace	Tazwell-Cary interval

Matching of the above listed steps with the conventional glacial scale gives the following:

Step No. I. .....Recession of ice after last Wisconsin glaciation.
Step No. II. .....Wisconsin I, or Mankato substage.
Step No. III. .....Two Creek interval.
Step No. IV. .....Wisconsin 2, or Cary substage.
Step No. V. .....Tazwell-Cary interval.
Step No. VI. .....Wisconsin 3, or Tazwell substage.
Step No. VII. .....Iowan-Tazwell interval.

or,

Formation	Geologic Time
Present flood plain	Recent
Power Plant Terrace	Two Creeks interval
Trinidad Terrace	Tazwell-Cary interval
Trinity Terrace	Iowan-Tazwell interval

The writers can find no evidence in the area studied to support Week's (1941) suggestion that there may have been an advance and retreat of the ice between the close of the Wisconsin stage and the growth and retreat of existing ice caps.

A growth and retreat of present ice caps may be reflected in the development of Power Plant Terrace and the present flood plain; the downcutting after Power Plant deposition being influenced by their growth, and the building of the present flood plain by their recession.

The fossils suggest a Wisconsin age for Trinity Terrace, and it is the writers' opinion that the Trinity Terrace fauna is slightly older than the Berclair and Ingleside faunas, which are considered to be Beaumont in age. Before any definite correlations can be made, either with other Pleistocene formations or the glacial scale, a great deal more information must be accumulated. On the basis of the information at hand, the following tentative correlations are suggested:

TABLE 7.—Tentative correlation of the glacial subdivisions of the Pleistocene of North America with the Trinity terrace and other Pleistocene formations of Texas.

Series		Stage	Substage
Recent		Glacial	Trinity River terraces and Pleistocene frtns.
		Ice retreat	Present flood plain
		Growth present Ice caps	
PLEISTOCENE	Wisconsin	Ice retreat	Power Plant Terrace
		Mankato	
		Ice retreat	Trinidad Terrace—Beaumont
		Cary	
		Ice retreat	Trinity Terrace—Lissie
		Tazwell	
		Ice retreat	High gravels—?Uvalde
		Iowan	
	*Sangamon		
	Illinoian		
	*Yarmouth		
	Kansan		
	*Aftonian		
	Nebraskan		

* Interglacial Units.

Conclusions.—After a study of the foregoing data in this report the writers conclude the following:

A. In regard to the Trinity Terrace fauna:

1. It is older than the Berclair and Ingleside faunas, which are considered to be Beaumont in age.

2. It is similar to the McKittrick fauna, the age of which is late Pleistocene.

3. It is related to Cragin Quarry fauna (Jones Ranch), which is correlated with the Wisconsin glacial stage.

4. It is definitely late Pleistocene in age, possibly belonging to the Tazwell-Cary interval of the Wisconsin stage.

B. In regard to the stream terraces:

1. The 3 well-developed alluvial terraces associated with the present stream and the present flood plain were deposited at different periods by stream alluviation, the aggrading being the result in a decrease in the gradient of the stream brought about by a rise in sea level caused by melting (recession) of glacial ice.

2. The different stages of downcutting by the stream, at which times erosional remnants of previous valley fill (terraces) were left at places along the stream's course, took place during a period of glacial expansion; the rejuvenation resulting from a lowering of sea level and possibly aided by coastward tilting of the land.

3. Entrenchment following deposition of Power Plant Terrace, lowest of the 3 terraces, possibly occurred during a period of growth of existing ice caps, and deposition of most of the present flood plain may be associated with their retreat.

4. Tentative correlation with other Pleistocene formations and the glacial scale is suggested as per Table 7.

ACKNOWLEDGEMENTS

Particular acknowledgement is made of the help given by the following persons: Dr. E. H. Sellards, Director of the Texas Memorial Museum and director emeritus of the Bureau of Economic Geology, University of Texas, Austin, Texas, who generously permitted the study of the fossils and made available other data from the files of the Bureau of Economic Geology; Mr. Glen F. Evans, Assistant Director of the Texas Memorial Museum, who provided a map of the area studied, and supplied other valuable information concerning the character and relationships of the Trinity River terraces; Dr. Keith M. Hussey, formerly Associate Professor of Geology at the University of Oklahoma, Norman, Oklahoma, who checked the field work; George H. Shaffer, who supervised the collecting of most of the fossils; and to Doctors R. A. Stirton, Professor of Vertebrate Paleontology, University of California, Berkeley, California; Claude W. Hibbard, Associate Curator of Vertebrates, Museum of Paleontology, University of Michigan, Ann Arbor, Michigan; Paul O. McGrew, Professor of Paleontology, University of Wyoming, Laramie, Wyoming; George G. Simpson, Curator of Fossils, Mammals and Birds, Department of Paleontology, American Museum of Natural History, New York, New York; and Chester Stock, Professor of Paleontology, California Institute of Technology, Pasadena, California, who, in response to a questionnaire, gave ideas on the age of the fauna.

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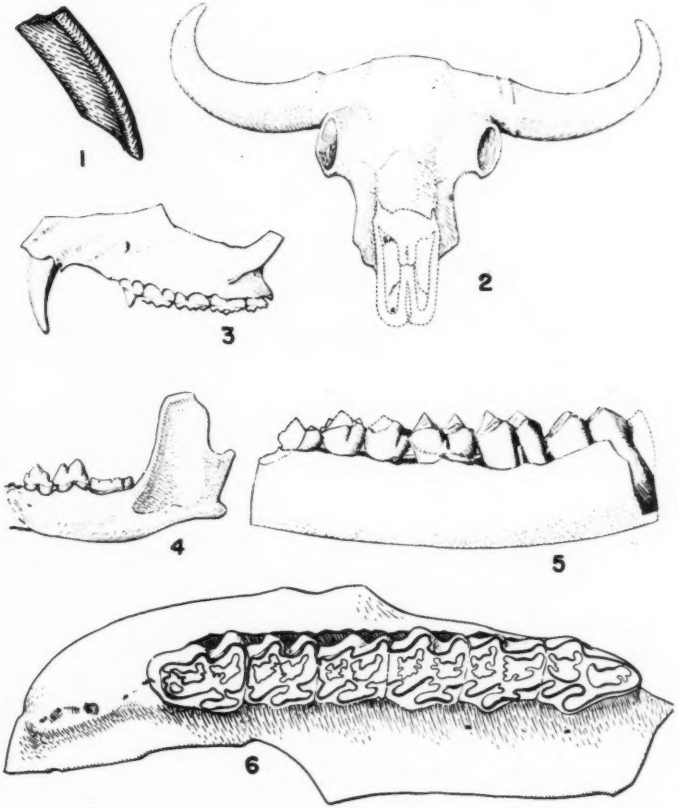

PLATE 1. Figs. 1-6.—1. *Castor* sp. Lateral view of incisor. (B.E.G.U.T. No. 30907-18A.) Size × 1.0 approx.; 2. *Bison occidentalis*. Facial view of skull. (B.E.G.U.T. No. 31538-1.) Size × 1/10; 3. *Didelphis virginianus*. Left maxilla containing canine, P3, MI-4, (B.E.G.U.T. No. 30907-63.) Size × 1/2; 4. *Canis* sp. Left. ramus. (B.E.G.U.T. No. 30907-14.) Size × 4/10; 5. *Odocoileus virginianus*. Portion of left dentary. (B.E.G.U.T. No. 30907-170.) Size × 8/10 plus; 6. *Equus complicatus*. Right side of palate. (B.E.G.U.T. No. 30907-41.) Size × 2/10.

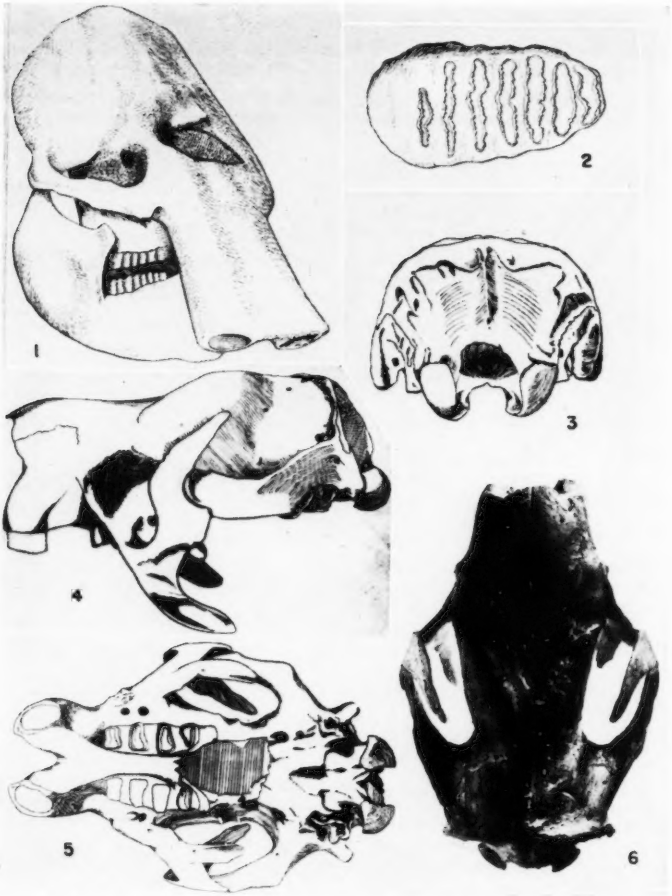

PLATE 2. Figs. 1-6—1. *Parelephas columbi.* Skull. (B.E.G.U.T. No. 30907-61.) Size × 1/18; 2. *Parelephas columbi.* 2nd lower milk tooth. (B.E.G.U.T. No. 30907-79.) Size × 3/5; 3. *Megalonyx brachycephalus* n. sp. Occipital view of skull. B.E.G.U.T. No. 30907-60) Size × 1/5, approx.; 4. *Megalonyx brachycephalus* n. sp. Lateral view of skull. (B.E.G.U.T. No. 30907-60.) Size × 1/5, approx.; 5. *Megalonyx brachycephalus* n. sp. Ventral view of skull. (B.E.G.U.T. No. 30907-60.) Size × 1/5; 6. *Megalonyx brachycephalus* n. sp. Dorsal view of skull. (B.E.G.U.T. No. 30907-60.) Size × 1/5.

Notes and Discussion

Isoetes melanopoda Still Grows in Illinois

JULIAN NEILL

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For a period of 40 years between 1908 and 1948 the quillwort *Isoetes melanopoda* Gay & Dur. remained unseen and uncollected in Illinois and came to be regarded as perhaps extinct.[1]

On June 18, 1948, the writer found *Isoetes melanopoda* growing in the American Bottoms east of East St. Louis, St. Clair County, collected specimens (*J. Neill* no. 1945), and deposited representative samples in the herbarium of the Missouri Botanical Garden. Dr. J. M. Greenman verified the identification. This is apparently the first collection of this species made in Illinois in 40 years and the first in St. Clair County in 66 years.

The plants were found in a wet, almost marshy, habitat associated with *Spartina pectinata* Link, and species of *Eleocharis* and *Carex*. The area is completely flooded once in every two or three years in the spring. The *Isoetes* colony covers an area of about one-half acre; the plants are for the most part scattered but in some places they occur in very dense stands.

On June 21, 1949, the writer visited this place again and collected specimens (*J. Neill* no. 3324). Two days later, the writer took Mr. Robert A. Evers, Assistant Botanist, Illinois State Natural History Survey, to this marshland, and Mr. Evers also collected specimens (*R. A. Evers* no. 18000) which he placed in the herbarium of the Survey at Urbana.

Known collections[2] made in Illinois prior to the writer's finding of the plant are as follows: Athens, Menard County, *Elihu Hall* in 1861 and 1865; Ringwood, McHenry County, *George Vasey* in 1863; Menard County, Fulton County, *J. Wolf* in 1874; Logan County, *F. Foerste* in 1881; St. Clair County, *H. Eggert* in 1881 and 1882; Stark County, *V. H. Chase* in 1908.

As *Isoetes melanopoda* is not extinct in Illinois, botanists in Illinois might well examine similar habitats with the hope of finding it in localities other than St. Clair County.

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1 ". . . perhaps now extinct in Illinois, since apparently the most recent collection is that of Mr. V. H. Chase in 1908. . . ." G. N. Jones, Amer. Midl. Nat. 38: 8, 1947.

2 From G. N. Jones' Flora of Illinois. Amer. Midl. Monogr. 2, p. 32.

Book Reviews

DRUG PLANTS OF AFRICA. African Handbook: 8. By Thomas S. Githens. The University of Pennsylvania Press, Philadelphia. 1948. viii+125 pp. $2.25 (paper).

To the reviewer whose undergraduate training was in pharmaceutical chemistry, this book brought back pleasant memories of pharmacognosy classes, particularly in the studies of the plants indigenous to Africa. Wormseed, Calabar Beans, Colchicum, Squill, Colocynth, Castor Beans, Poppy, Absinthe, to mention only a few, strike a reminiscent chord and serve to emphasize the economic importance of this crude drug industry in Africa.

In the preface, written by Dr. John M. Fogg, Jr., of the Botany Department at the University of Pennsylvania, it is pointed out that this book is an attempt to compile and examine the great store of information—and misinformation—concerning the therapeutical values of the native plants. If we consider the intensive studies in our own country on those crude drugs used by the Indians and the early settlers we can better appreciate the problems which confront the researcher in combatting the empiricism which flourishes in the use of hundreds of drugs by the primitive peoples of Africa.

In the introductory chapter Dr. Githens mentions "the doctrine of signatures" which persists in the use of drugs by the natives. "Thus a plant like hepatica, with leaves lobed like the liver, is believed to be useful in diseases of that organ." Since the number of plants used by the various tribes and peoples on that continent is very great, the author has presented the most essential data for each species in tabular form, and more detailed descriptions are reserved for a few of the more important genera.

In the second chapter, "The Chemical Basis for the Use of Drug Plants," Dr. Githens lists the various plant constituents and gives examples of those found in the African plants. While this portion is interesting and easily readable, it is unfortunate that it was necessary to delete much fascinating material for the sake of brevity.

The third chapter, "Utilization of Drug Plants," deals with the study of the drug plants of Africa. For convenience these are listed into four groups: 1) those plants in which the medical use is of secondary importance, 2) plants not native to Africa but which are cultivated for local use or for export, 3) plants used by the natives chiefly as arrow poisons, or as ordeal or homicidal poisons, and 4) native and introduced plants used by the native medicine men in the treatment of bodily ailments.

The remainder of the book is made up of tables which summarize in compact form the information of economic and scientific interest on these drugs.

This volume is a very valuable addition to the set of African Handbooks being published by the University of Pennsylvania, and it will be of particular interest to the pharmacognosist, the chemist, or to the drug buyer. A volume on the romance of these drugs would be fascinating, albeit perhaps not too valuable from a technical viewpoint.—L. H. BALDINGER, University of Notre Dame, Notre Dame, Indiana.

VERNALIZATION AND PHOTOPERIODISM—A SYMPOSIUM. By A. E. Murneek, R. O. Whyte, et al. Chronica Botanica Company, Waltham, Mass. 1948. viii+196 pp., plates, text figures, illustrations. $4.50.

Investigators in the field of plant physiology will recognize this publication as an important contribution in the field of plant development. Presented in eleven sections and three special supplements, this symposium is a critical discussion of factors concerned with the physiology of flowering in plants. Each section is written by an authority in his particular field, and presents a comprehensive review of research on the relationship of light and temperature to physiological ontogeny in plants.

The foreword by K. V. Thimann poses some basic and broad questions and problems, and indicates probable trends in research on plant development. He states: ". . . the state of the field is such that a single clear-cut result might change its whole aspect almost overnight." "The consequences of major progress in this area are very great, not only for pure science but for agriculture. In these days when so much of the world is near to starvation no worker can fail to carry this thought in the back of his mind, in spite of the frequent

statement that research is its own reward and that no further incentive is necessary. One purpose of a symposium like the present publication is to enable the individual student to effect something of a synthesis in his views. Such a synthesis can hardly fail to engender new ideas and thus to quicken the pace of progress."

Titles of the various sections and supplements are as follows: History of Research in Vernalization, by R. O. Whyte; History of Research in Photoperiodism, by A. E. Murneek; Hormones in Relation to Vernalization and Photoperiodism, by Karl C. Hamner; Wave Length Dependence and the Nature of Photoperiodism, by H. A. Borthwick, M. W. Parker and S. B. Hendricks; The Photoperiodicity of Flowering Under Short Day with Supplemental Light of Different Wave Lengths, by G. L. Funke; Nutrition and Metabolism as Related to Photoperiodism, by A. E. Murneek; Anatomical and Histological Changes in Relation to Vernalization and Photoperiodism, by R. H. Roberts and B. Esther Sturkmeyer; Length of Day in the Climates of Past Geological Eras and Its Possible Effects upon Changes in Plant Life, by H. A. Allard; Vernalization and Photoperiodism in the Tropics, by S. M. Sircar; Some Preliminary Observations of Phenological Data as a Tool in the Study of Photoperiodic and Thermal Requirements of Various Plant Material, by M. Y. Nuttonson; Thermoperiodicity, by F. W. Went; Studies on Photoperiodicity in the Tropics, by Erwin Bünning; The Developmental Physiological Meaning of the Endogenous Daily Rhythm in Plants, by Erwin Bünning, and Contributions to the Genetics of Photoperiodism, by A. Lang. A list of the literature cited in each section is given immediately following the section and separate author and subject indices have been compiled for the entire volume.

To the knowledge of the reviewer, this is the first book on this subject matter to be printed in the United States, and will help cover that phase of plant physiology, which, in the words of Thimann, "has as yet no basis in the general physiology and biochemistry of the plant." With respect to subject matter, illustrations, graphs, tables, format and type, the editors and contributors to this volume are to be commended.—EDWARD W. SYBIL, University of Notre Dame, Notre Dame, Indiana.

PRINCIPLES OF HUMAN GENETICS. By Curt Stern. W. H. Freeman and Company, San Francisco. 1949. 628 pages, 198 illustrations. $5.50.

The design of the author in writing this text was primarily twofold. First to present the basic principles of the science of genetics as illustrated by the genetics of man and second to serve as a source of information concerning problems in human genetics for physicians, psychologists, anthropologists, social workers and similar individuals whose professional problems are often fraught with genetic implications. In addition he had hopes that the book would also have some appeal to all persons who are interested in establishing a good human society. It seems to the reviewer that the author has been admirably successful in carrying out these aims.

One of the novel features of the book aside from the fact that it is the first textbook in genetics at the college level based on human heredity, is the brief but excellent presentation in the first five chapters of the biological and mathematical background upon which an understanding of the principles of genetics is based. Especially noteworthy is the author's inclusion, in this section in chapter three, of a thorough going exposition of the dynamics of gene action.

The main body of the book consisting of chapters 6 to 22 presents the basic principles of genetics as illustrated with examples from studies carried out on human inheritance. In this section the basic principles are not only clearly elucidated but the special techniques which must be applied in the study of inheritance in man are also presented in a simple but adequate manner. Interspersed among these chapters there are discussions of phases of the subject which pertain especially to human problems such as the chapters dealing with the problems of genetic advisers, medicolegal genetics, prenatal interactions, and consanguinity.

The final five chapters deal with the broad social aspects of human genetics. The author handles this difficult section wisely and effectively, avoiding the expression of extreme

points of view he presents factual information where it is available and impartially presents the arguments of both sides of the question in the more controversial cases.

It is to be regretted that an all-round good book should be so marred by the very poor reproduction of the illustrations. It is to be hoped that in subsequent editions improvements will be made in this respect.

The bibliography is presented in the usual manner in the form of selected references at the end of each chapter. In addition a brief literature citation accompanies many of the figures and tables. At the end of most of the chapters there is a small group of selected genetic problems. While my examination of these was of necessity somewhat cursory they seemed to be of the type that would be useful and helpful to the student in attaining a grasp of the genetic principles and understanding of the techniques which they were designed to illustrate.—WILBUR M. LUCE, University of Illinois, Urbana.

DICTIONARY OF GENETICS (Including Terms used in Cytology, Animal Breeding and Evolution). By R. L. Knight. Chronica Botanica Company. 1948. xii+ 183 pp. $7.50.

During a half century of rapid development of the science of genetics, an extensive technical vocabulary has developed. The close relationship of genetics to cytology and evolution requires that the vocabularies of these sciences be included in any glossary of genetics. Together, they make up an immense vocabulary which has not been the subject of a technical dictionary previous to the publication of Knight's *Dictionary of Genetics*.

The present volume thus fills a real need. Its coverage is fairly comprehensive, and the definitions are generally quite clear. None the less, it leaves much to be desired. Etymologies are not given at all, nor is there any indication of pronunciation. Authorities are cited for a few of the definitions, but only for a disappointingly small proportion of the total number. Some of the definitions are much too superficial for a dictionary intended for specialists. Thus amnion is defined as "one of the foetal membranes." As chromosomin is defined, it might be expected that the better established components of the chromosomes would also be given, yet the reviewer did not find globulin, histone, nucleic acid, protamine, ribonucleic acid, or thymonucleic acid. The salivary gland chromosomes are defined without mentioning their giant size. None of the definitions is illustrated.

The usefulness of the volume is enhanced by the inclusion of a series of appendices which present formulae and mathematical tables, as well as some other information frequently used in genetics.

In spite of all of these criticisms, Knight's *Dictionary of Genetics* is still a useful volume. But its usefulness will increase greatly if it is thoroughly revised in a future edition. It is rare that a dictionary is the product of one man. Usually a large board of specialists works under the direction of an editor. Perhaps the vocabulary of genetics and its allied sciences has grown to such volume that a really first class dictionary of genetics could only be produced in this way.—EDWARD O. DODSON, University of Notre Dame, Notre Dame, Indiana.

COLLEGE ZOOLOGY. By George W. Hunter, III, and F. R. Hunter. W. B. Saunders Company, Philadelphia and London. 1949. vii+821 pp., 490 illus. $5.50.

This textbook, obviously intended for use in a two semester course, is divided into six sections comprising 33 chapters. Each chapter is preceded by an outline and is followed by a list of selected references, and a brief descriptive classification where appropriate. Section I, limited to a single chapter, introduces the student to zoology through the ecological aspect. The second section, consisting of three chapters, is designed to furnish an understanding of the scientific method, the cell, tissues and the organ-systems. Section III, divided into 12 chapters, is confined to the invertebrates or, more properly, the nonchordates. The introduction is followed by chapters devoted to each of the larger groups. Although this section, exclusive of the first, contains only 11 chapters, actually 19 separate phyla are considered. It seems certain that differences of opinion will arise among invertebrate zoologists with regard to the classification as well as the sequential arrangement of

the phyla. Included is one chapter entitled, "Miscellaneous Phyla of Minor Invertebrates," which might more appropriately be termed the "Waste Basket Assamblage." Included are the following phyla: Nemertinea, Trochelminthes, Gastrotricha, Bryozoa, Brachiopoda, Chaetognatha, and Phoronidea. Unfortunately no attempt has been made to link one group with another by indicating relationships with its closest relative. The fact that these small heterogeneous phyla are included in a single chapter will tend to give the student the impression that they form a link in the evolutionary chain. The fourth section, comprising 11 chapters, is devoted to the chordates as a unit, with emphasis on the physiology and morphology of the higher vertebrates, especially man. The treatment of the vertebrate classes should have been expanded so that they would more nearly balance the space given the different classes of the invertebrate phyla. Embryology, genetics, and evolution, each treated in a separate chapter, comprise section V. The sixth and last section includes chapters on the social life of animals, parasitism and disease, and conservation and the use of the environment. It is the opinion of the reviewer that it would have been better if the information contained in this section had been woven into previous chapters, rather than isolated. Following this is a glossary, a film bibliography, and an index. The film bibliography will prove very useful to some instructors and although the glossary is doubtless a valuable aid to the student, its usefulness would have been substantially increased if the etymology of the terms defined had been included. It seems unfortunate that the following were not included in connection with pertinent chapter references: R. R. KUDO. *Protozoology*. 3rd ed. xiii+778 pp., 336 figs. (4 col.) Charles C. Thomas, Publisher, Springfield, Ill., 1946. BEN DAWES. *The Trematoda*. xvi+644 pp., 80 figs. Cambridge University Press, London and New York, 1946. GEOFFREY LAPAGE. *Nematodes Parasitic in Animals*. x+172 pp. Methuen and Co., Ltd., London, 1937. H. J. VAN CLEAVE. *Invertebrate Zoology*. 2nd ed. xiv+282 pp., 126 figs. McGraw-Hill Book Company, Inc., New York and London, 1931. G. S. CARTER. *A General Zoology of the Invertebrates*. xxviii+ 509 pp., 172 figs. The Macmillan Company, New York, 1940.

This book, in keeping with the high standard established by the publisher, is attractive in format, generously illustrated, and the number of typographical errors is surprisingly few. The illustrations are many and generally good, but perhaps over simplified in some instances. Certain illustrations show little resemblance to the species they are intended to depict, inasmuch as they appear distorted by the absence of essential detail. Details are the indispensable implements of the subject, which should be disregarded only when popularization is sought. The authors are to be complimented for the inclusion of so much recently published information, a desideratum seldom attained in a book of such general nature.

Realizing that the publication was an ambitious undertaking it may seem unjustified to offer adverse criticism, yet there are several inconsistencies and a few mistakes which are slightly disturbing. These, to some, might appear trivial but to the student they contribute nothing but confusion. For instance, on pages 90 (fig. 49) and 157 (fig. 89) the outer and inner layers of the coelenterate drawings are labeled, epidermis and gastrodermis respectively; while on pages 156 (fig. 88) and 163 (fig. 96) the same definitive structures are labeled respectively ectoderm and endoderm. If the reviewer is not mistaken, the organism figured as *Arcella* (p. 116, fig. 60) is more likely a *Difflugia*. Sycon (*Grantia*) [sic, p. 145] implies the latter is a subgenus of the former, which is not the case. Furthermore, *Sycon* has been suppressed in favor of the genus *Scypha*. On page 172, in the text, and in figure 104, the aperture in the turbellarian body through which the pharynx protrudes is designated as the mouth; yet in figure 100 (p. 172) the terminal opening of the pharynx is indicated as the mouth. On page 235 and in figure 150 the anterior portions of the lumbricid nervous system are correctly indicated; yet on page 233 (fig. 148), the identical structures are labeled supra- and subesophageal ganglia. If it was the authors' intention to bring the turbellarian nomenclature up to date, *Dugesia* should have been employed instead of *Euplanaria*. The illustration of a "typical leech" (p. 229, fig. 144) is not only confusing but incorrect. The posterior portion of the alimentary tract fails to agree with the condition found in the Glossiphoniidae, of which the specimen illustrated apparently is a representative. Completeness and clarity would have resulted if the seminal receptacles, included in figure 152 (p. 237), had been labelled. The statement on page 245 concerning the mouth parts should be corrected to read "jaws" instead of "teeth." Furthermore, even when thus corrected, it applies only to the Hirudidae and not to the

Hirudinea as a whole as the text implies. One begins to wonder when, if ever, there is going to be an end to the ubiquitous inclusion in our general zoology textbooks of *Hirudo medicinalis*, a species unavailable now and only occasionally available in apothecaries of the larger cities and a few biological supply houses, as a result of European importations, prior to World War II. Equally typical indigenous species are available which, in the opinion of the reviewer, should supplant the timeworn illustrations originally taken from European texts. The discussion (p. 368) concerning the longitudinal arrangement of the tube feet of *Thyone briareus* is incorrect, because in *Thyone* spp. the podia are scattered over the whole surface.

Despite the volume's shortcomings, many of which can be corrected in the next printing and others in the second edition, it remains a valuable and stimulating book and doubtless will be widely adopted.—MARVIN CLINTON MEYER, Department of Zoology, University of Maine, Orono.

THE AVIAN EGG. By Alexis Romanoff. John Wiley and Sons, Inc., New York. 1949. xiii+918 pp., illus. $14.00.

In this impressive book, containing 800 pages of text, and more than 2600 reference citation, there is strict adherence to the subject matter implied by the title. Many phases of the morphology and chemistry of the eggs are reviewed, as well as economic aspects, and even some social uses of the eggs of birds. The intensity of this admirable consistency is exemplified on page 31, where a distinction is made between birds on the one hand, and "animals" on the other.

The volume is synthesized from data drawn from an extremely wide range of fields. It would be only natural for a work of such detailed yet explicit writing to become a useful and frequently consulted reference. For this reason it is perhaps regrettable that relatively little information is included concerning species other than domestic fowl and a few game birds. The developmental properties of the egg are not taken up except for brief descriptions of maturation and cleavage. Examples of the kinds of information included in this encyclopaedic work are such diverse data as (1) the effect of weather on intensity of egg laying, (2) the biochemistry of egg shell color, (3) mathematical analysis of egg shape, (4) microscopic structure of the shell and membranes, (5) breaking strength of shells, (6) pH variation in the hen's oviduct, (7) endocrine factors in ovogenesis, (8) double-yolked eggs, (9) United States standards of quality for marketed eggs, and (10) coloring of Easter eggs.—AUBREY GORBMAN, Barnard College, Columbia University, New York City.

THE SALTICIDAE (SPIDERS) OF PANAMA. By Arthur M. Chickering. Bulletin of the Museum of Comparative Zoology 1946. vol. 97, pp. 1-474, 432 figs. $4.50.

This paper presents the results of an intensive taxonomic study of the jumping spiders, or Salticidae, of Panama, based primarily upon collections made by Dr. Chickering himself during three summers spent in field work in that area, but also involving a review of the Peckham and other collections at the Museum of Comparative Zoology. The work continued over a period of ten years and is the most extensive of a series of similar studies by the same author on other groups of Panamic spiders. The present paper well illustrates the amazing richness of species in the tropics revealed by intensive collecting and study. In his personal collections the author recognizes from the area 172 species of which eighty-one are described as new, this bringing to more than 200 the species of Salticidae, representing some sixty-two genera, now known from Panama. The genera are referred to two subfamilies—the Lyssomaninae and the Salticinae. The genera of the Salticinae for convenience, are arranged in groups believed to be natural. Keys are given to the subfamilies, groups, genera and species. The descriptions of species are adequately detailed and are accompanied by illustrations in ink of the anatomical details regarded by the author as taxonomically most significant, and with indication or discussions of synonymies. This revision should prove a helpful foundation for future students of the Salticidae of Panama and adjacent areas while at the same time supplying data useful to those who may seek to clarify the still unsatisfactory taxonomy of the intriguing spiders of this vast family.—R. V. CHAMBERLIN, University of Utah, Salt Lake City.